REPORT

OF THE

U. S. Dept. of Agriculture,

COMMISSIONER OF AGRICULTURE

FOR

THE YEAR 1884.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1884.

JOINT RESOLUTION providing for printing the Annual Report of the Commissioner of Agriculture for the year eighteen hundred and eighty-four.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That there be printed four hundred thousand copies of the Annual Report of the Commissioner of Agriculture for the year eighteen hundred and eighty-four; three hundred thousand copies for use of members of the House of Representatives, seventy thousand copies for use of members of the Senate, and thirty thousand copies for the use of the Department of Agriculture.

SEC. 2. That the sum of two hundred thousand dollars, or so much thereof as may be necessary, is hereby appropriated, out of any money in the Treasury not otherwise appropriated, to defray the cost of the publication of said report.

Approved July 1, 1884.

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REPORT

OF

THE COMMISSIONER OF AGRICULTURE.

DEPARTMENT OF AGRICULTURE,
Washington, D. C., November 10, 1884.

To the PRESIDENT:

I respectfully submit a statement of the work done in the Department of Agriculture during the year 1884.

During the year the duties of the Department have largely increased. The extension of the work of the Bureau of Statistics has furnished the chief a large amount of matter, which he has with great diligence and skill reduced to statistical form and embodied in a monthly report, which has attracted great attention both in this country and in Europe. In addition to Mr. Moffatt, who reports from London upon the trade and industry of Europe, there are ten thousand correspondents of this Department in this country, who are constantly furnishing the materials for the statistical estimates of the Bureau. The establishment of a Bureau of Animal Industry in the Department has also added very largely to its duties, and the work required by it has been most satisfactorily performed. The Bureau of Entomology has been most efficiently represented abroad by its chief, and its investigations in this country have been conducted with great care and success. I submit extended statements of the work of these several bureaus.

BUREAU OF ANIMAL INDUSTRY.

This Bureau, established by act of Congress approved May 29, 1884, has been organized during the year, and it is now in active and efficient operation. Investigations have been made in regard to the extent, nature, and means of combating outbreaks of communicable diseases among the domesticated animals of the country in the States of Maine, Connecticut, New York, New Jersey, Pennsylvania, Maryland, Virginia, Tennessee, Kentucky, Ohio, Indiana, Illinois, Missouri, Kansas, Arkansas, and Texas. While the prevalence of such diseases is probably not much in excess of what it has been in previous years, the organization of the Bureau has led to a greatly increased number of

demands for information on the subject, and the existence of dangerous diseases has been more promptly and fully reported than heretofore.

Scientific investigations in regard to the nature and cause of contagious diseases among animals have been constantly in progress, and are throwing much light on the difficult problems which are encountered by those who practically attempt to reduce the ravages of these plagues. An extended microscopic investigation of American pork has been made to learn what foundation there was for the charge of trichinous infection which has been brought against it in Europe.

A great mass of information has been collected in relation to the development and needs of the various branches of the live-stock industry, with a view of enabling the owners of animals of all kinds to escape preventable losses, and to direct their efforts in the most promising direction.

The practical direction of the quarantine system, which was transferred to the Department of Agriculture by the Secretary of the Treasury in accordance with a recent act of Congress, has been made one of the duties of this Bureau. The professional knowledge of the chief, who must be a competent veterinary surgeon, taken in connection with the information which is being continually received by this Bureau as to the presence of contagious diseases in those foreign countries from which we import cattle, and the most advanced methods of controlling these diseases, makes it peculiarly appropriate that the protection of American cattle from imported diseases should be in the same hands.

In a word, the labor of this Bureau has been directed to prevent and control communicable diseases among animals in this country, to prevent the importation of such plagues from abroad, and to collect such information as is valuable to the stock-grower and necessary to the profitable development and conduct of our animal industries, and to enable us to secure free entrance for our animal products into the markets of the world.

Congress has provided for the publication of fifty thousand copies of the first annual report of the Bureau of Animal Industry. This report will be issued simultaneously with this volume, and will contain a vast amount of information of great value to breeding, rearing, and the general traffic in live stock.

GARDENS AND GROUNDS.

The work of this division consists, in part, in introducing, propagating, and distributing economic plants, particularly of such kinds as seem worthy of trial and experiment, both in regard to congenial climates and their probable value as furnishing economic industries. Work of this nature is necessarily of a tardy character, and at best is likely to be somewhat limited in useful results.

Testing new varieties of what are known as small fruits has been a prominent and popular feature of the work of this division, but it is

now almost abandoned on account of the abridged area which can be devoted to culture, and also for the important reason that the exposed condition of the grounds and their proximity to the city offer facilities to depredators to destroy plants and rob them of their fruits before they can reach a degree of maturity necessary to decide upon their merits. The small area of arable land, which is yearly encroached upon by the erection of necessary buildings, limits the facilities of propagating and cultivating plants for distribution; but the most is made of it, and, together with the glass structures used for the purpose, an average of 100,000 plants of various kinds are annually produced and distributed.

Among the most notable introductions and additions to our standard orchard fruits, the Japan persimmon may be mentioned. Satisfied as to the superior value of this fruit, wherever it can be planted in a suitable climate, importations have been made from time to time, and for several years past, from its native country. The earliest of these importations, made some fifteen years ago, were disseminated over a wide range of territory, in order to fully test the hardiness and fruiting capacity of the plants in different climates and localities. After this had been virtually determined, the more recent and more valuable importations have been distributed only in localities where the plants can survive in all seasons, and where the fruit can be produced in perfection. This fruit is now being extensively propagated and planted with a view to profitable culture, and it is quite probable that in a few years it will be familiar in our markets.

The citrus family of plants has been and is receiving considerable attention. The constant inquiries for information regarding oranges, lemons, limes, &c., and the demand for plants, has been met as far as the Department has been able to do so. Various importations have been made of the best varieties obtainable in other countries. A small but choice variety, known as the Tangierine, was early introduced, and has become very popular and of much commercial value in orange-growing localities. Subsequently, plants of a variety imported from Bahia were distributed about twelve years ago, and in California it is regarded and recognized as the most valuable orange produced in that State. It is known in commerce as the Washington Navel orange, in order to distinguish it from other Navel oranges, of which there are numerous varieties. Another valuable kind, imported from Europe, is named *Melitensis*. This variety has not been largely distributed as yet, but is expected to prove to be distinct, valuable, and popular when better and more extensively known.

The importation of Russian apple-trees was made some years ago by the Department, scions of which were very extensively distributed to nurserymen and others, and are now receiving much attention, as the collection includes many varieties which are considered by orchardists to be of great value in regions where apple culture had hitherto proved unprofitable. These hardier kinds resist much cold, and have

therefore been instrumental in extending the culture of this fruit into northern regions where other varieties have failed.

Native grapes and strawberries are propagated to some extent. These are mostly distributed in newly-settled localities, and, as they bear fruit at an early age, are specially useful in introducing fruit culture among pioneer farmers.

The records of this Department indicate that the commencement of fruit culture in States now famous for their productions in this line has been significantly due to the early distribution of plants through its agency.

The progress of the tea plants at the station near Summerville, S. C., is reported by the superintendent as being perfectly satisfactory. The plants are now large enough to afford, during the early summer of next year, leaves in sufficient quantities to warrant an effort at tea manufacture, if such an operation may be deemed necessary.

That the Chinese tea-plant can be grown over a large portion of the United States, and that good teas have and can again be made from such plants, are facts which are not matters for dispute or surmise; but whether teas can be produced of standard qualities to meet the requirements of commerce, and in sufficient quantities and at a cost which will be profitable to the planter and to the manufacturer at the prevailing prices of that commodity, are questions which have not been practically demonstrated on a proper scale. But the factors of successful tea production in other countries are well understood; and it is equally well recognized that in some essential conditions (a principal one being a deficiency in the average rainfall) there is sufficient reason for caution in planting the large area which makes success possible even in the most favorable climates. The capability of growing the plant has not for half a century back been a question of doubt in all localities where the thermometer does not reach a lower point than from eight to ten degrees above zero.

The demand for semi-tropical and tropical plants, from residents of the warmer climates of this country, increases yearly. These demands are somewhat perplexing, for the reasons that seeds of the plants called for are rarely to be found in commerce, and are therefore difficult to procure in reliable condition; and, again, demands are made for many species of plants which the Department is perfectly well convinced cannot be grown advantageously in any part of the United States.

The hardiness of tropical plants depends upon the altitude of their native habitats. Altitude and latitude are almost synonymous terms in plant life. Tropical plants, if taken from high altitudes on mountain slopes, will stand severe colds and even frosts, and are therefore fitted to grow in what might be comparatively quite northern latitudes.

The climates of the United States are peculiar in the respect that even the most northern State has a summer, more or less lengthy, which is strictly tropical in its temperature. During this period the

thermometer will average as high a range as in strictly tropical countries. This tropical period lengthens as we proceed southward, until Southern Florida is reached, where it extends to about eleven months out of the twelve which constitute the year. But this period, more or less, of cool weather, liable to an occasional freeze, is sufficient to to destroy all vegetation which is strictly tropical in its nature. It is therefore only by experimental tests that the adaptability of plants to climates or locations other than their native ones can be truly demonstrated. With this view, it is proposed to continue the introduction, as far as practicable, of all plants whose economic value entitle them to recognition.

BUREAU OF STATISTICS.

With the increase of area in cultivation and of variety in production the work of collecting statistics of agriculture in this country is constantly enlarging. The rapidity of agricultural progress and the local irregularities of its movement tend to increase its difficulty and diminish its accuracy; on the other hand, a growing public appreciation of its importance is a means of higher efficiency, as well as its surest guarantee.

The field work of this branch of the department service is obviously a matter of observation, comparison, and estimate, and not an actual count of a census. The swift changes of the alternating seasons must be summed up with instant celerity; their effects on ultimate production must be discounted with practicable closeness before the crops are matured. An accurate report of a harvest as soon as it is gathered is stale news for the public or interested buyers. It is the aim of the Statistician to keep abreast of the expectations of the day in instantaneous crop reporting. There are nearly ten thousand selected observers in the ranks of the reporters to the Department and to the State agents, who are selected with reference to their judgment and means of local observation. They are officers of agricultural societies, or men of mark in agricultural experience and general intelligence. Their accuracy and reliability are manifestly enlarged with increasing experience. This is attested by their returns, which exhibit greater unity and reasonableness of statement from year to year. Formerly the averages of returns of yield per acre were uniformly too high; now they approach a figure that is nearer the test of actual measurement. The prevalent custom of averaging the actual results of the harvest, as in the case of thrashers' records, is one means of aiding the public judgment of what an average really is. There are many evidences of a better understanding among farmers of the value and necessity of agricultural statistics to themselves, to the consuming masses, to political economy and the science of government.

It would be impossible to realize the development of our agriculture without the aid of statistical investigation, which shows, according to the report of the Statistician, that in two decades, between 1860 and

1880, the value of meats increased from $300,000,000 to $800,000,000; of corn, from $360,680,878 to $694,818,304; of wheat, from $124,635,545 to $436,968,463; of hay, from $152,671,168 to $409,505,783; of dairy products, from $152,350,000 to $352,500,000; of cotton, from $211,516,625 to $271,636,121, and other products in proportion, more than doubling the aggregate of value, increasing it from $1,600,000,000 to $3,600,000,000 in round numbers. With good prices the current production of the agriculture of the United States can be little short of four billions of dollars; and the values are those of the home markets, and not of the eastern commercial cities or ports of exportation.

The investigations of the past year show a tendency to farther increase of the area of corn and cotton and of most of the principal crops of the country. The wheat area is so much beyond the requirements of consumption in this and other countries as to depress the price to a point unprecedented in recent years, favoring at certain points the use of wheat in feeding for pork production. The cause of this superabundance is two-fold—first, the extension of settlement in the northwestern prairies and the dry plains of the Pacific coast; and, second, the extraordinary period of comparative failure of European wheat for several consecutive years. The progress of settlement must be less rapid hereafter, and already the lean years of Europe have been followed by comparative plenty.

These facts of products and prices point to the sharp necessity of adapting production to consumption, to supply food products now imported, to give remunerative employment to agricultural labor and food in variety, and cheapness to consumers.

The present year's history of crop growth, in the records of this Bureau of the statistics of agriculture, indicates a production above the average, a season of peculiar prosperity, with no serious failures. Drought alone, in a portion of the producing area, has wrought some reduction of the rate of yield. The cotton crop has been somewhat injured by this cause, yet the crop promises nearly 6,000,000 bales. Corn apparently averages about 26 bushels per acre, which is about the average of the prior period of ten years, giving a crop not heretofore exceeded in absolute quantity. Wheat has made a yield of fully 13 bushels per acre, and a product exceeding 500,000,000. The supply of cereals will average fully 50 bushels for each inhabitant. Potatoes of both kinds are fairly abundant, and other products generally in full supply. Altogether, the year is one of positive, if not exceptional, fatness.

This Bureau has been active during the year in the work of collecting and co-ordinating the official statistics of State departments, boards of agriculture, and of commercial organizations, and exploring the domain of fact in all departments of agricultural effort and experiment. In addition to the work of our duplicate system of domestic crop-reporting, the effort to obtain early information of European crop production

and supply has been successful. Our agent in London is gradually extending and perfecting his machinery for collection of desired and prompt information. The Division of Railroad Transportation has also been efficient in the work of reporting changes of rates of transportation, to which it was assigned by direction of Congress.

BUREAU OF BOTANY.

During the past year the work of this Bureau has been prosecuted with vigor.

Very numerous inquiries from correspondents of the Department relating to plants, seeds, fruits, grasses, &c., have been properly considered and and answered.

An increased interest in the subject of agricultural and other grasses has been manifested, and numerous inquiries have been received from different parts of the country for such information on that subject as would enable farmers and others to obtain a knowledge of the common cultivated and wild grasses occurring in the various sections of the country. In order to meet this demand, the botanist has prepared a pamphlet on the "Agricultural grasses of the United States," to which is added a paper on their "Chemical composition," by the assistant chemist, and this pamphlet has been published by the Department. It is believed that this work will supply a widely-felt want on this subject.

The work of improving and perfecting the herbarium has been steadily carried forward, and very important additions have been made to it by contributions, exchanges, and purchases. One large box of botanical specimens has been received from the Museum of Natural History of Paris, France. One box containing over 800 specimens has been forwarded to the same institution. Also, one box of 800 specimens has been sent to the Royal Herbarium of St. Petersburg, Russia, and other packages to prominent specialists in Europe and this country.

The work of distribution of our duplicate specimens to agricultural colleges and other institutions of learning has been continued. Among those to whom such duplicates have been sent are the following: The Colorado Agricultural College, at Fort Collins; the Ogontz School, Montgomery County, Pennsylvania; the Hillsdale College, Michigan, and the Media Academy, Media, Pa. Several boxes of sections of our native woods have been distributed as follows: One box to the Perkins Institution for the Blind, Boston; one box to the Media Academy, Media, Pa; one box to Hillsdale College, Hillsdale, Mich.; one box to the Northwestern University, Evanston, Ill.; and one box to P. H. Dudley, esq., New York City.

BUREAU OF CHEMISTRY.

During the past year the Bureau of Chemistry has been engaged in the following investigations and miscellaneous work:

1. A continuation of the study of American cereals with reference to the composition of the grains, their relation to moisture, variation in

size, &c., as influenced by environment. The effect of differences in rainfall and temperature in different seasons produces a greater change in the composition of the grain than peculiarities of soil.

2. A study of the "Roller Milling Process" for the manufacture of flour, especially with reference to the hard spring wheats of the Northwest. The results comprise both a physical and chemical examination, and are of considerable interest.

3. A series of baking experiments with flours of different grades from all parts of the country. The result of this investigation has been to show that the weight of bread produced from a given weight of flour is almost entirely dependent on the percentage of moisture in the flour rather than upon the quality or the amount of gluten in it. These experiments were conducted, primarily, for comparison with those of the McDougal Brothers in England a short time ago, which did not result very favorably for American flours as regards quantity. Our results show a much higher yield than was found abroad. The preceding work has been published in detail in Bulletin No. 4 of this Bureau.

4. The examination of American dairy products, begun last year, has been continued. Some of the results will be found in the report of the Chemist.

5. An extended investigation of maple sugars and maple sirups has been completed, showing the presence of numerous spurious or adulterated articles in the market.

6. An investigation of a series of soils from Louisiana and some other parts of the country, with a view to their exhibition at New Orleans at the World's Cotton and Industrial Exposition.

7. A study of the sugar industry of the country, including experiments and practical work with sorghum here and in Indiana, Illinois, Wisconsin, and Kansas, and an examination of the status of the beet-sugar industry on the Pacific coast. The Department has also established a laboratory on a plantation in Louisiana for the purpose of making a thorough chemical investigation of the processes there employed in the manufacture of sugar.

8. The miscellaneous work increases very largely every year, and our facilities are hardly equal to the amount which must be done. Since our last report between two and three hundred analyses of fertilizers, marls, minerals, mineral waters, well waters, ensilages, hay, and other [illegible]ers, have been completed, in addition to our regular work. The [illegible] of the advisability of erecting a building suitable for the [illegible] cannot, [illegible] of these facts, be long delayed.

[illegible] ENTOMOLOGY.

[illegible] in its various lines of usefulness, [illegible]on from all parts of the country. The [illegible] previously inaugurated have been continued [illegible] completed, while others have been instituted and

carried on not only at the Department, but in several different parts of the country by special agents, and notably in California, Nebraska, Indiana, New York, Massachusetts, Rhode Island, and Maine. Important discoveries have been made as to the insect destruction of forest trees in Maine, the enemies of the cranberry and hop crops, those affecting wheat and small grains in the West, and those affecting the orange and other fruit trees. These will be found recorded in the report of the Entomologist. Two special bulletins, containing some of the more practical results of these investigations, have been published during the year, and the fact that the chief remedies and insecticide appliances now quite generally employed with satisfaction, and constantly discussed and recommended in the agricultural press, have originated during my administration of the Department very well illustrates the original and useful character of the work emanating from this Bureau. While much knowledge of a purely scientific character is naturally acquired, I feel that the chief end of the Bureau should be to teach the farmer to save as much as possible of the loss which he often sustains from insect injury. The present Entomologist fully appreciates this position, and has eliminated, as far as possible, such technical descriptions as would not be appreciated by the mass of intelligent farmers.

During the year various questions relating to the Phylloxera have been referred to the Department through the Secretary of State, questions that have chiefly grown out of the treaty of Berne, which has caused much unnecessary delay and loss to both importers and exporters of nursery stock, for it has been shown that there is no good reason for detaining such stock at the port of New York when destined for any part of the country east of the Rocky Mountains. The use of kerosene emulsion as a remedy for this underground vine pest, proposed by the Entomologist a year ago, after due experiment, has attracted much attention, and, upon invitation of the French minister of agriculture, I sent Professor Riley to Europe during the summer to demonstrate his proposed methods of dealing with the insect, and to learn what he could that would be of benefit to our people, as to the present status of the American vines in France, and of the Phylloxera question in general. He also studied certain practical features of silk culture upon which we needed more exact knowledge, and visited the International Forestry Exhibition at Edinburg. It is pleasant to know that while much information that will be useful to us has thus been obtained, the benefit has been mutual, to judge by the appreciative manner in which the recommendations of the Entomologist were received, and the honor conferred on him as a delegate from the Department. In advanced agriculture all civilized nations have to-day so many interests in common that increasing reciprocal relations become necessary.

The Bureau has continued its labors for the promotion of silk culture in the United States during the past year, and has been greatly aided by the sum of $15,000 appropriated at the last session of Congress for

the encouragement and development of the industry. Prior to July 1 the work in connection with this subject was performed by the ordinary force of the Bureau and manuals of instruction, and silk-worm eggs were distributed to applicants in all parts of the country. In accordance with the act appropriating the sum above named, I have appointed a special agent, who, under the direction of the Entomologist, will devote his whole time to the investigation of all subjects relating to "the culture and raising of raw silk." These include, among others, an examination into the extent of the interest already shown in the industry by the people of the United States; the climatic adaptability of our country to this art, and its present sericicultural resources. To these may be added a study of the means employed abroad to encourage silk raising, in which study the division has been greatly aided by certain valuable reports made by our representatives abroad to the honorable Secretary of State.

Arrangements have been made for the continuation of the distribution of literature, silk-worm eggs, and mulberry trees to all such as may desire them during the coming year, and to further the establishment of profitable reeling.

A new impetus has thus been given to silk culture by the late act of Congress, and the industry seems in a fair way to be added to the list of those which, though at one time considered essentially foreign, have become so successful in our country.

The Entomologist has also prepared for the exposition at New Orleans an elaborate collection of injurious and beneficial insects; of the chief insecticides and insecticide machinery and appliances, together with an exposition of bee culture and silk culture.

BUREAU OF FORESTRY.

The work of this division has been prosecuted during the present year on the plan adopted by me in the reorganization of the division. Through the agents in the field circulars of inquiry have been sent out, more especially to those parts of the country deficient in a natural growth of trees, asking information as to the kind of trees the planting of which has been attended with success, as well as those the planting of which has been followed by failure, and the causes of such failure. To a large percentage of these circulars, amounting to many thousands, replies have been made. This information is now in the hands of the printer and will soon be available for public use. Its publication will be of great economic value to the country by enabling those engaged in tree planting, the number of whom is rapidly increasing, to avoid the mistakes and consequent losses which have hitherto occurred for lack of the knowledge thus given, and which have often been so discouraging to the planter.

The agents of the Bureau have also been making personal observations in regard to important subjects connected with the growth and preservation of our forests, the results of which have been reported to the division and will be given to the public.

While the destruction of our forests is going on at a constantly increasing and alarming rate, it is gratifying to know that the work of planting trees for wind-breaks and for forest purposes is rapidly increasing, especially in some of our western States and Territories. From Nebraska, for instance, we have trustworthy information that not fewer than 4,500,000 trees have been planted during the present year, and more than two thousand bushels of walnut and other tree seeds. Constant inquiries by letters from all parts of the country are made of the division in regard to tree-planting, requiring much time for the proper replies, but clearly showing the useful place which such a division holds.

Continued investigations have been made in regard to the consumption of the forests both for legitimate purposes and by fire. The consumption for the manufacture of lumber is increasing in a greater ratio than is warranted by the increase of population and the consequent natural demand. The lumber market is largely overstocked, and the process of manufacture continues to be conducted in a wasteful manner, when the rapidly decreasing source of supply calls for the utmost economy of material. At a recent convention of lumbermen at Chicago, representing an estimated capital of $500,000,000, and called for the purpose of improving the condition of the market by securing a check in the rate of production, it was stated that the stock of lumber then on hand was sufficient to supply all legitimate demands for eighteen months if not another tree should be cut or sawn.

But the convention was unable to effect any agreement for the curtailment of production, and it was left to go on as individual interest should determine. So far, therefore, as the forests of the country are in private hands, there seems little reason to hope that their rapid consumption by the ax and by fire can be checked. In one of our States, owing to the laws regulating the assessment of taxes, we are able to ascertain the amount of forests relatively to the whole area of the State from year to year for thirty years past. The official returns from that State show a steady diminution of the forest area during that period, and not only in the State as a whole, but in every county, with a single exception.

The great pine forests of the Northwest are now depleted to such an extent that the Southern pine is brought into competition with it in the Chicago market, and perceptible inroads have already been made upon those vast forests which cover so large a portion of the Gulf States. The same reckless and wasteful methods of lumbering are pursued there which have so rapidly consumed the Northern and Western forests.

This condition of things makes more imperative every year the endeavor to preserve the forests which form a part of the public domain, and so to guard and control them by law as to make them of greatest and most lasting benefit to the country.

Since the appropriation was made by Congress for the purpose of aiding the Centennial Exposition at New Orleans, this Bureau has been engaged in the endeavor to exhibit one of the practical and economic aspects of forestry by securing for that exposition specimens of the manufactured products of the forests. For this purpose wood-working factories in various parts of the country have been visited or have been reached by means of correspondence, and as the result a great variety of articles of most useful and interesting character have been secured, which, when brought together, cannot fail to impress the beholder with a new sense of the value and importance of our woodlands. From the toy that amuses the child on the floor to the ship that breasts the ocean storms in interchanging the commodities of the nations, the forests will thus be seen to minister to us in ways almost innumerable.

An instructive contribution to the New Orleans Exposition will also be made by the Bureau in the form of a grove of living trees transplanted from the arid region of the West, where it has been held that trees could not be made to grow on account of the limited amount of rainfall. This transplanted grove will be an ocular demonstration that the establishment of trees both for ornamental and forest purposes can be pushed much farther along the dry western plains than has been supposed, and will be a great encouragement to their settlement.

DEPARTMENTAL REPORTS.

Congress, at its last session, provided for the printing of 400,000 copies of the Annual Report of the Department, and also for the printing of 50,000 copies of the First Annual Report of the Bureau of Animal Industry. The following-named special and miscellaneous reports have been issued by the Department during the current year:

BUREAU OF STATISTICS—NEW SERIES.

	No. copies printed.
No. 4. Report upon the numbers and values of farm animals, on certain causes affecting wages of farm labor, and on freight rates of transportation companies. February, 1884, 56 pp., octavo	11,000
[illegible] on the distribution and consumption of corn and wheat, and [illegible] rates of transportation of farm products. March, 1884, 44 pp., octavo	11,000
[illegible] of the area of winter grain, the condition of farm animals, [illegible] freight rates of transportaion companies. April, 1884, 48 [illegible]	11,000
[illegible] condition [illegible] winter grain, the progress of cotton planting, [illegible] timates [illegible] of 1883, with freight rates of transportation [illegible] 1884, 36 [illegible], octavo	13,000

	No. copies printed.
No. 8. Report of acreage of spring grain and cotton, the condition of winter wheat, and European grain prospects, with freight rates of transportation companies. June, 1884, 40 pp., octavo	11,000
No. 9. Report on the area of corn, potatoes, and tobacco, and the condition of growing crops, and on rates of transportation. July, 1884, 60 pp., octavo	12,000
No. 10. Report on the condition of growing crops and on rates of transportation. August, 1884, 36 pp., octavo	13,000
No. 11. Report on condition of crops, on wheat in India, and on freight rates of transportation companies. September, 1884, 88 pp., octavo	13,000
No. 12. Report on condition of crops, yield of grain per acre, and on freight rates of transportation companies. October, 1884, 44 pp., octavo	13,000

ENTOMOLOGICAL BUREAU.

Bulletin No. 4.—Reports of observations and experiments in the practical work of the division, made under the direction of the Entomologist, together with extracts from correspondence on miscellaneous insects. January, 1884, 102 pp., octavo	3,000

CHEMICAL BUREAU.

Bulletin No. 2.—Diffusion—its application to sugar-cane, and record of experiments with sorghum in 1883. By H. W. Wiley, Chemist. January, 1884, 36 pp., octavo	5,000
Bulletin No. 3.—The Northern sugar-cane industry. A record of its progress during the season of 1883. By H. W. Wiley, Chemist. April, 1884, 120 pp., octavo. Accompanied by isothermal charts	3,000
Bulletin No. 4.—An investigation of the composition of American wheat and corn. Second report. By Clifford Richardson, Assistant Chemist. September, 1884, 98 pp., octavo	2,500

BOTANICAL AND CHEMICAL BUREAUX.

The Agricultural Grasses of the United States. By Dr. George Vasey, Botanist of the Department of Agriculture. Also, the chemical composition of American grasses. By Clifford Richardson, Assistant Chemist. July, 144 pp., octavo, accompanied by 120 full-page engravings of American grasses	3,000

MISCELLANEOUS.

Proceedings of a National Convention of Cattle Breeders, and others, called in Chicago, Ill., November 15 and 16, 1883, by Hon. George B. Loring, Commissioner of Agriculture, to consider the subject of contagious disease of domestic animals. 86 pp., octavo	5,000
Special Report No. 3.—Mississippi: its climate, soil, productions, and agricultural capabilities. By A. B. Hurt, special agent. 80 pp., octavo	10,000
Special Report No. 4.—The climate, soil, physical resources, and agricultural capabilities of the State of Maine, with special reference to the occupation of its new lands. By Samuel L. Boardman, State agent of Maine for the Department of Agriculture. 60 pp., octavo	6,000
Special Report No. 5.—The proper value and management of timber lands, and the distribution of North American forest trees, being papers read at the United States Department of Agriculture, May 7 and 8, 1884. 48 pp., octavo	10,000

SEED BUREAU.

Tabulated statement showing the quantity and kind of seeds issued from the Seed Bureau, Agricultural Department, under the general appropriation act of Congress, from July 1, 1883, to June 30, 1884, inclusive.

Description of seeds.	Varieties.	Senators and Members of H. of R.	Statistical correspondents.	State correspondents.	Miscellaneous applicants.	Grand total.
		Packages.	*Packages.*	*Packages.*	*Packages.*	*Packages.*
Vegetables	128	2,033,407	131,423	40,670	146,035	2,351,535
Flowers	131	329,135	101,760	29,825	103,418	563,638
Herbs	21	....	50	....	199	249
Tobacco	5	105,451	401	1,735	7,084	114,671
Tree	1	465	139	20	1,056	1,680
Sunflower	1	220	....	....	345	565
Opium poppy	1	....	....	....	36	36
Pyrethrum	2	....	9	....	228	237
Field seeds:						
Wheat	6	41,862	19,264	486	7,678	69,290
Oats	2	6,621	46	....	3,210	9,877
Corn	4	19,062	32	1	1,171	20,266
Barley	1	4	12	....	258	274
Buckwheat	1	391	62	8	288	749
Potatoes	2	7,619	4,162	16	432	12,229
Rye	1	....	....	....	1	1
Sorghum	3	8,576	21,122	150	4,511	34,359
Turnip	7	347,482	78,376	....	....	425,858
Sugar beet	2	....	6	....	100	106
Mangel-wurzel	2	2	....	....	60	62
Grass	2	6,662	63	10	2,099	8,834
Clover	4	897	68	5	648	1,618
Cow-pea	5	....	....	2	137	139
Artichoke	1	....	856	....	8	864
Millet	1	4,441	22	4	445	4,912
Rice	1	....	18	....	84	102
Textile:						
Cotton	1	433	14	18	101	566
Hemp	2	....	....	....	16	16
Flax	1	....	....	....	2	2
Jute	1	....	....	....	3	3
Ramie	......	....	....	....	....	....
Grand total	......	2,912,730	357,905	72,450	279,653	3,622,738

The following table exhibits in a condensed form the appropriations made by Congress for this Department, the disbursements, and unexpended balance for the fiscal year ending June 30, 1884:

Object of appropriation.	Amount appropriated.	Amount disbursed.	Amount unexpended.
Salaries	$127,640 00	$127,639 87	$0 13
Collecting statistics	80,000 00	....	....
Laboratory	*16,842 18	16,829 26	12 92
Purchase and distribution of seeds, &c	75,000 00	74,986 48	13 52
Experimental garden	7,500 00	7,486 21	13 79
Museum	1,000 00	993 51	6 49
Furniture, cases, and repairs	6,000 00	5,998 82	1 18
Library	1,500 00	1,439 86	60 14
Investigations as to insects, &c	20,000 00	19,704 86	295 14
Investigating the diseases of swine	25,000 00	24,011 85	988 15
Reclamation of arid and waste lands	*17,656 13	16,286 89	1,369 24
Report on forestry	10,000 00	9,998 30	1 70
Postage	4,000 00	3,841 48	158 52
Contingent expenses	14,000 00	13,991 43	8 57
Improvement of grounds	8,000 00	7,962 67	37 33
Building (greenhouse)	2,500 00	2,500 00	....

* Including unexpended balance of appropriation for 1883.

Very respectfully,

GEO. B. LORING,
Commissioner of Agriculture.

REPORT OF THE CHEMIST.

DEPARTMENT OF AGRICULTURE,
BUREAU OF CHEMISTRY,
November 12, 1884.

SIR: I have the honor to submit the following synopsis of the work done in this Bureau during the past year. That portion relating to milk and butter has been prepared by myself. The *résumé* of the condition of the sugar industry has been compiled from my reports by Mr. Clifford Richardson, during my absence from Washington.

Respectfully,

H. W. WILEY,
Chemist.

Hon. GEORGE B. LORING,
Commissioner of Agriculture.

THE NORTHERN SUGAR INDUSTRY IN 1883.

The results of extended investigation of this industry in all parts of the country, and of laboratory and experimental mill-work conducted under my superintendence at Washington, have appeared as Bulletins Nos. 2 and 3 of the Chemical Division.

The present status of the sugar question, as there defined, may be understood from the following abstract:

It is nearly thirty years since the sorghum plant was introduced into this country; but such have been the methods of investigation and practical work that it is not yet decided whether it can be used with success as a sugar-producing plant.

The problem presents itself under two distinct heads—the scientific, or theoretical, and the economic, or practical.

The scientist, looking at it from the position of the mere analyst, determines the fact of the presence of sugar in the sorghum, and, as an investigator, the adaptability of different chemical procedures to the separation of the sugar from the cane. The economist, on the other hand, taking the statements and methods of the scientist into consideration, regards the problem merely as to the possibilities of making money under the conditions placed before him. The work of this division has been necessarily, to a large degree, of a purely scientific nature. The results of economic work in different parts of the country have, however, been, as far as possible, observed and gathered together.

IMPORTANCE OF METEOROLOGICAL CONDITIONS FOR THE SUGAR INDUSTRY.

The four sugar-producing plants of practical importance—the sugar-cane, the beet, the sorghum, and the maple—are suited to very different climatic conditions.

The tropical cane, while it is the richest of all, is practically limited to an extremely small belt in the South.

The maple and beet are best suited to high temperate latitudes, while the sorghum seems destined to claim the middle temperate conditions for its peculiar field.

Certain varieties, like the Amber, reach maturity in an extremely short period of growth, and it is possible that careful selection of seed may extend the range over which the sorghum may be successfully grown, and the belt of country may become a wide one. It should be remembered, however, that this belt should be bordered by lines of isothermacy and not by parallels of latitude.

In discussing the geographical limits of sorghum culture it has been usual to say that they are the same as for maize. This is both true and false—true in that the early varieties of sorghum will grow as far north as our corn, and the late ones as far south; false in the assumption that the mere growing of sorghum is enough to insure success in making sugar from it. Not only must there be time for growth but also for manufacture. The effect of cold weather on sorghum cane may be summarized as follows:

(1.) A frost severe enough to kill the blades of immature cane will spoil it for sugar-making.

(2.) Such a frost on ripe cane will not do it any notable injury.

(3.) A frost severe enough to congeal the water in the cells of the cane will render it unfit for sugar-making immediately on the accession of thawing weather. To determine the length of the working season, therefore, is to know (1) the time of ripening of the cane, *i. e.*, when the seed is hard, and (2) the time when the first severe frost is likely to take place.

The shortest period of maturity is probably in the neighborhood of 100 days, and in the latitude of Chicago the working period which could be depended on would not exceed six weeks, as early frosts are possible in the middle of October.

In length of working season the beet appears to have a great advantage over sorghum. As is well known, the beet is harvested before any freezing weather and put in silos. Here it is kept during the winter months, or until it is sent to the mill. If the temperature of the silos is kept low enough the beets will retain their sugar until the following spring. Beet-sugar factories in Europe sometimes keep running until March or April.

The advantage of keeping the machinery in use for as long a time as possible is one which will be keenly appreciated by every manufacturer. The cost of a sugar-factory plant is very great. Machinery is injured more by idleness than by use. The shortness of the working season, therefore, becomes a difficulty the most serious to the success of the sorghum business.

An experiment on the preservation of sorghum in silos showed that cane buried on the 12th of November, 1883, which contained about 9 per cent. of sucrose and 3 per cent. of other sugars, still retained on January 14, 1884, 8.39 per cent. sucrose, with 2.36 per cent. of other sugars. On February 27 there were present 7 per cent. and 3.13 per cent., respectively, and on April 1, 5.89 and 3.72 per cent. The value of these facts for the manufacturer can only be determined by a practical test on a large scale. If there is no means of preserving the cane we are again driven to a selection of proper climatic conditions for quick maturity and long working season. Cape May, N. J., seems to be a favorable locality in these two respects, as proved by the experience of

the Rio Grande Company. By following the isotherms of this locality westward, a line may be traced, south of which, as far as thermal conditions are concerned, the cultivation of sorghum *for sugar* can be carried on with a hope of success. Years of experience will be necessary before we are sufficiently acquainted with other meteorological conditions, such as rainfall, humidity, and local circumstances of environment, to fix the most favorable limits for the culture of the plant.

The question is equally an open one with the beet, and together with sorghum, a study of the most favorable conditions of climate, soil, fertilizers, and other elements of environment will be the problem of the future.

SEED.

The importance of the best seed cannot be too strongly insisted on. The beet industry of the continent owes its success in a large measure to the improvement in the root by careful seed selection and cultivaton. This has hardly been attempted with sorghum, and many years of patient work will be necessary before the result is felt.

In the same way with the beet, it may be necessary that a seed should be sought for this plant adapting it to our soils and climate. At any rate it is evident that foreign seed will not produce in our hot and dry summers, as a usual thing, a beet rich in sugar.

In California the beet is a greater success than elsewhere in the United States. In fact, all the beet sugar made in 1883–'84 was at Alvarado, Cal.

The following letter of Mr. E. H. Dyer, superintendent of the Standard Sugar Refinery, Alvarado, Cal., will show the character of the work which is doing in California with the sugar beet:

H. W. WILEY, Esq.,
Chemist, Department of Agriculture, Washington, D. C.:

DEAR SIR: Yours of 5th instant received. In answer to your inquiry in regard to the amount of sugar made in campaign 1883–'84, will state that our whole product has not yet been marketed. We only had beets enough to run about ninety days, owing to the unusually dry season that prevented the farmers from sowing only about one-half the usual acreage. We sent to market, however, 1,027,826 pounds *white refined sugar*, and probably have in tanks, in process of crystallization, 250,000 pounds more. The percentage of sugar obtained was very satisfactory. As this season promises to be a favorable one, we expect to have from 15,000 to 20,000 tons of beets. Last year we only had about 7,000 tons.

The five years' experience of the Standard Sugar Refinery has fully proven that beets raised in California will yield as many tons per acre and are as rich in saccharine matter as any produced in Europe. With the aid to this industry that its importance deserves for a few years, sufficient capital would be invested in the production of beet sugar to stop all importation of foreign sugar on the Pacific coast, and supply a large portion of that required east of the Rocky Mountains. We have a soil and climate well adapted to the production of the sugar beet extending from California to British Columbia. There is room for one hundred factories of a daily capacity of 150 tons each; and with the same encouragement by our Government as the manufacturers in Europe received in the earlier stages of the industry, they would be built in less than 10 years. I will gladly give you any information in regard to the subject that I have, fully realizing that the future success of this important industry depends greatly, if not wholly, upon the encouragement given it by your Department. I intend visiting Washington during the session of Congress for the purpose of trying to obtain a modification of the internal-revenue laws that will permit alcohol distilled from beet molasses, to be used solely for mechanical purposes, to be exempt from taxation.

Yours, respectfully,

E. H. DYER.

From this letter of Mr. Dyer, it is evident that the manufacture of sugar from the sugar beet is an assured success on the Pacific coast.

There is a vast region of country in Northern California, Oregon, and Washington Territory of which the climate and soil are suitable to this plant. When the extent of this region is considered it does not seem that Mr. Dyer's views of the future are exaggerated.

Analyses of California beets, a few in number, have been made by P. Cassamajor and published in the Sugar Beet (vol. 5, No. 1), and several others in the State itself.

(1) Imported Vilmorin beet: Density of juice, 26° Balling. Coefficient of purity, 82°.6.

(2) Early Red Top beet: Density of juice, 23°.2 Balling. Coefficient of purity, 82°.5.

(3) Verbesserte Imperial Rose: Density of juice, 20°.5 Balling. Coefficient of purity, 83°.

No.	Variety.	Degree, Brix.	Sucrose by polarization.	Coefficient of purity.
1	Early Rose	19.5	16	82.05
2	Vilmorin Imperial	20.5	16.7	81.46
3	Verbesserte Imperial Rose	19	15.2	80
4	......do	17	14.4	80

The yield per ton of the California beet is most gratifying. Seven thousand tons of beets were worked. The yield per ton on the basis of the sugar already marketed is 147 pounds. Allowing for the estimate of Mr. Dyer that 250,000 pounds of sugar are yet to be separated, the total yield reaches 182 pounds per ton.

These figures should prove of the greatest interest to the farmers of the Pacific slope, for in them they should see suggestions of greater wealth than is found in their mines.

A few beets have been, of late, examined from Eastern localities. The beets analyzed in the following table were raised by Mr. William Cartwright, of Oswego, N. Y. He planted a space of 46,708 square feet in beets, and the total yield was 36,000 pounds.

Analysis of beets from Oswego, N. Y.

Variety.	No. of analysis.	No. beets taken.	Weights.	Weight with neck removed.	Sucrose.	Glucose.	Ash.	Purity.
			Kilograms.	*Kilograms.*	*Per cent.*	*Per cent.*	*Per cent.*	*Coef.*
Improved, south field, north end.	1	5	2.838	Not taken	12.12	.29	1.022	74.6
Massachusetts, improved	2	5	2.963	....do.....	12.58	.20	1.079	77
Late-planted, pitted in field	3	5	1.961	....do.....	11.22	.22	1.049	71.0
Improved, south field, south end.	4	5	2.457	2.238	15.34	.17	0.775	83
Improved, north field, north end.	5	5	2.776	2.610	15.32	.16	0.862	85
Improved, north field, south end.	6	5	2.795	2.540	15.20	.12	1.061	82
Oswego seed	7	5	2.902	2.532	14.52	.14	0.983	80
Government seed:								
Sub. Green Neck	8	5	2.477	2.010	12.54	.14	0.985	74
Rose Neck	9	4	2.807	2.598	12.24	.31	1.099	77
Sublime, 1883	10	4	4.272	3.822	11.06	.32	1.166	72
From Hart's field	11	5	2.915	2.810	12.74	.40	0.897	79
Late-planted	12	6	2.020	2.020	12.64	.32	1.250	78.5

ANALYSES OF SUGAR BEETS SENT BY MR. LEVI MAISH, YORK, PA.

Beets sent November 22, 1883. Analyzed December 19, 1883.

No.	Variety.	No. of beets.	Total weight.	Weight without neck.	Sucrose.	Glucose.	Ash.	Purity.
			Kilos.	*Kilos.*	*Per cent.*	*Per cent.*	*Per cent.*	*Coef.*
1	Vilmorin Improved.....	4	2.924	2.684	8.04	.40	1.37	64.3
2	White Silesian..........	3	2.892	2.610	7.24	.78	1.57	58

By comparing the analyses of the latter beets with those from Oswego, the great superiority of the latter is at once manifest.

York, Pa., seems to be too far south for successful culture of the sugar beet, and analyses recently made of beets grown in Washington show a still worse result, illustrating the effect of climate upon the root.

SORGHUM.

But to return to a consideration of the general characteristics of the sorghum cane, of which less is known than of the beet. Its tendency to rapid change after cutting is a serious fault, and no amount of improvement by culture will be able to eradicate it. Canes, as has been shown, can be preserved in silos, and we have even found it possible to transport them for long distances for the purposes of analysis by covering the end with melted paraffine. Rapid changes of temperature, however, especially in green or frosted canes, produce inversion and fermentation. The conditions have not been carefully studied, and it is, in fact, a difficult histological problem. Tropical cane is very different in its characteristics, a specimen, after two weeks, having nearly 16 per cent. of sucrose and only a little over one of other sugars. The fact illustrates the difficulties which the presence of so large an amount of solids not sugar, which are ready to produce fermentation and inversion in the juice of the sorghum, introduces into the successful development of the industry. With beets this difficulty is avoided, but others more easily overcome are met.

Owing to these impurities, only a certain portion of the sugar present in the juice of either sorghum or beet is available. Its amount depends on the percentage of juice extracted from the cane, and the ratio of sucrose to the other bodies in the juice.

Long experience has shown that each equivalent of substance not sugar in the juice prevents a like quantity of sucrose from being obtained in a crystalline state. To this we must add another result of experience, viz., that about 5 per cent. of the sucrose is lost in the process of evaporation. Applying these data to a cane yielding a juice containing 10 per cent. sucrose, 2.75 per cent. of other sugars, and 2 per cent. of solids not sugar, or in all 4.75 per cent. of solids not sucrose, we find that only 5.25 per cent. of the sucrose remains available. If the 5 per cent. of the whole is lost on evaporation, then only 4.75 per cent. would be obtained from the juice, or, on an average yield of juice, only 2.37 per cent. from the cane, or 46.4 pounds per ton.

The yields of the factories of the country from which returns were obtainable make it doubtful if any of them exceeded this. The data may be found in my original report. The report of one of the most successful factories is appended:

RIO GRANDE, N. J., *December* 6, 1883.

SIR: The mill commenced grinding September 10 and stopped November 14. The amount of unstripped cane ground was 6,795,811 tons. We made 282,711 pounds sugar and about 55,000 gallons molasses.

Sucrose by polariscope, average for the season	per cent..	9.75
Sp. gr. Baumé, average for the season	degrees..	7.57
Against last year's polariscope	per cent..	11.11
Sp. gr. Baumé	degrees..	7.33

The bulk of the crop was Amber and Orange; the per cent. of juice ranged from 55 per cent. to 40 per cent. on the unstripped canes, over half the sugar being left in the bagasse.

We have two mills; the second one was not properly rigged up.

Being afraid the cane would get over-ripe, as it has always done before, we planted later than usual. The season turned out very wet and cold. The Orange did not ripen until October 29, except in those fields where phosphoric acid was put in the hill. A storm in September prostrated the Amber. For these two reasons we had bad cane from September 24 to October 29. During this time no pan failed to granulate, but the yield of sugar was poor. From October 29 until the end of the season the cane was first rate. The extreme low price of sugar and the high price of choice New Orleans molasses caused us to make a better sirup than we would ordinarily have done. In this way over 100,000 pounds of sugar was allowed to go into the molasses simply because this year it paid to do it.

Yours truly,
H. A. HUGHES,
General Manager Rio Grande Sugar Company.

Prof. H. W. WILEY.

Table of data derived from preceding letter.

Acres (about)	1,000
Tons	6,795
Tons per acre	6,795
Pounds sugar made	282,711
Pounds sugar per ton	41.6
Gallons molasses	55,000
Gallons molasses per ton	8.09
Average per cent. of sugar in juice	9.75
Average per cent. of juice expressed	47.00
The total value of sugar produced, at 7 cents per pound, was	$19,789 77
Add bounty, 1 cent per pound	2,827 11
Value of molasses, at 42 cents per gallon	23,100 00
Bounty on cane ($1 per ton)	6,795 00
	52,511 88
Value per acre (*circa*)	$50 00

The yield, it will be seen, did not equal that which has been calculated. A portion of the sugar was, however, not recovered from a desire to make a high-grade molasses.

OUR OWN EXPERIENCE WITH CANE GROWN NEAR WASHINGTON.

From our own experience it has been learned that single milling, *i. e.*, passing canes through one three-roll mill, gives so poor a yield that it must necessarily be abandoned at least with sorghum. Tropical canes seem to mill better than the stalks of sorghum, and single milling of such canes may continue to prove profitable. It is evident, however, to every practical worker, that a system of expression which gives only 45 to 50 per cent. of the total juice of the cane is too wasteful to meet the continued approval of farmers and manufacturers.

Double milling is doing much to remove this difficulty. This division has made only a few experiments with double milling, and these show a yield of nearly 65 per cent. of weight of cane. In the establishments where this process only has been used, estimates have been made of its efficiency. These estimates, however, may be wide of the truth, but we may safely say that double milling increases the yield of juice 10 to 15 per cent.

The soil in the vicinity of Washington is not suitable to the growth of sorghum cane. It is true the yield of cane this season was far better than it has ever been heretofore since the Department undertook

experiments with cane-raising in this locality. When, however, careful planting and cultivation and liberal fertilizing, combined with a fairly favorable season for growth, fail to produce 10 tons of cane per acre, it must be admitted that there is a radical defect of soil. The climate of Washington, however, is peculiarly favorable to cane-growth. Early springs, warm summers, and late falls are all that the practical cane-grower could demand. A sandy loam appears to be the most favorable soil for cane. Yet, it should not be forgotten that sorghum is a hardy plant; it will grow even under the most unfavorable conditions, and rarely proves a complete failure.

Manufacturers and intending manufacturers should not base their calculations for the yield of sugar on working canes containing 12 per cent. sucrose and only 1.5 to 2 per cent. of other sugars. It is doubtful whether any field of sorghum of 10 acres extent has ever been raised which would give such an average result. In the present state of the industry it would be much safer to count on 9 per cent. sucrose, 3 per cent. other sugars, and 2 per cent. solids not sugar, as an average of the crop from year to year.

This division would be guilty of a great public wrong were it by any kind of select results or enthusiastic coloring to induce capitalists to invest money where they would be led to expect a higher return than the actual facts warrant.

The results obtained this year, poor as they are compared with those of former years, may nevertheless prove of great advantage to those who are proposing to practically engage in the sorghum-sugar industry by causing them the more carefully to consider all the difficulties which they will have to meet.

The violent northeast storm which occurred at the beginning of the working season completely prostrated the Amber cane. The heads of this variety of cane were heavy. As soon as the ground was softened by the rain the stalks could no longer resist the force of the wind. The Amber canes were so nearly mature that they had no power of recuperation and remained prostrate. A few stalks only of the Amber remained standing. Ten days after the storm a few of these canes were collected for analysis. For comparison the same number of fallen canes were taken at the same time and from the same locality. The fallen and standing canes were as nearly alike in size and general appearance as a careful selection could make them. On October 8 another similar collection was made.

The results of the analyses of these canes are found in the appended table:

Comparative analyses of fallen and standing canes, illustrating effect of wind storm on canes.

No. of analysis.	Date.	Condition of cane.	Specific gravity.	Total solids.	Sucrose.	Other sugars.	Total sugars.	Albuminoids.	Ash.	Coefficient of purity.	Available sugar.	Number of canes.
	1883.			*Per ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	
1	September 20	Standing	1.0692	15.665	11.84	3.12	14.96	......	.543	75.7	8.01	15
2	do	Down	1.0662	14.501	10.45	3.80	14.25	.213	.448	72.0	6.40	15
3	September 21	Standing	1.0708	16.758	11.88	3.01	14.89	.256	.617	71.0	7.00	25
4	do	Down	1.0571	13.359	8.39	3.64	12.03	.244	.541	62.6	3.37	25
5	October 8	Standing	1.0734	17.074	11.99	2.76	14.75	......	.475	70.2	6.91	6
6	do	Down	1.0660	15.775	10.34	3.80	14.10	......	.436	65.5	4.90	6

Comparative analyses of fallen and standing canes, &c.—Continued.

No. of analysis.	Date.	Condition of cane.	Total weight.	Weight of clean canes.	Weight of heads.	Weight of blades.	Weight of bagasse.	Per cent. of heads.	Per cent. of blades.	Per cent. of juice.
	1883.		*Kilos.*	*Kilos.*	*Kilos.*	*Kilos.*	*Kilos.*			
1	September 20	Standing	9.280	6.992	1.477	.812	2.339	15.9	10.5	70.1
2	do	Down	9.550	7.236	1.359	.956	2.350	14.2	11.7	67.5
3	September 21	Standing	10.433	7.796	1.609	.924	2.790	15.5	10.6	64.2
4	do	Down	......	6.024	1.446	.698	2.060	......	10.4	65.8
5	October 8	Standing	3.260	......	......	......	1.400	......	......	......
6	do	Down	2.560	......	......	......	1.020	......	......	......

The above analyses show that the effect of leveling the canes is most disastrous. The percentage of available sucrose was diminished by at least two units from the effect of the storm. Inasmuch as the percentage of available sugar in the juices worked was, in round numbers, three, it is seen that had there been no storm the amount of sugar made from the cane would have been nearly doubled.

In all localities subject to equinoctial storms the above figures will be of considerable interest.

OUR OWN EXPERIENCE IN INDIANA.

In Indiana experiments under my supervision gave more encouraging results.

Five acres of Early Amber cane were there cultivated for the Department on light sandy loam which would produce 20 bushels of corn, and had had no fertilizer. The young plants suffered from cold, wet weather and a frost on the twenty-eighth day from planting. The cane was injured by a heavy storm just before harvesting and was gathered wet. It weighed 48 tons, and was estimated equal to 46.8 tons dry.

From the following figures can be seen the result obtained:

Juice expressed	gallons	5,309.0
Specific gravity	Baumé	7.95
Temperature	degrees F.	68.8
Weight of juice expressed	pounds	46,932.0
Juice expressed (gross weight cane)	per cent	50.0
Juice expressed (net weight cane)	do	55.9

The mill used was Squeir's No. 2 Louisiana.

The semi-sirup made amounted to 1,014 gallons, measured cold; specific gravity, 27° B.=1.225. One gallon, therefore, weighs 10.17 pounds; total weight, 1,014 gallons=10,312 pounds.

This semi-sirup was put in barrels and sent to Washington by freight. It arrived there on October 25, and was immediately boiled in the vacuum-pan.

The crystals were easily started in the pan, and grew to full size in about ten hours.

The melada was ready for the centrifugal as it came from the pan, and some of it was swung directly from the pan, yielding 50 per cent. of good sugar.

The weight of sugar obtained from the cane was 2,860 pounds. This gives a percentage of 3.39 on clean cane ground and 6.09 per cent. of the weight of juice expressed.

The result of the experiment was in every way encouraging, and served in a manner to diminish the disappointment which attended the work in other directions.

A yield of over 60 pounds of sugar to the ton when only 50 per cent. of the weight of cane was obtained in the expressed juice is an indication of what may be obtained in the future with better milling or a more thorough extraction of the sugar by other methods.

From Illinois it was learned that a severe frost so injured the cane on September 8 and 9 that the results obtained were far from satisfactory. One hundred and sixty thousand pounds of sugar were, however, made from 4,660 tons of cane, and 35,000 gallons of molasses.

In Italy, Amber cane was grown and examined under Government auspices during 1882.

From the laboratory examination these conclusions were drawn:

1. The culture of Amber sugar-cane may very probably give in our country a rich yield of crystallizable sugar, as it does in that American State (Minnesota) from which the plant was originally brought.

2. By prolonging the time which intervenes between the harvest of the sorghum cane and its analysis the juice obtainable therefrom and its percentage in sucrose diminishes, while there is not always an increase of glucose. Perhaps by putting the cane under the ground and moistening it before this is done the losses may be considerably reduced.

3. The upper internodes and the peripheric strata of the cane seem to yield a greater abundance of saccharose than the lower internodes and the central strata, so that it would seem advisable not to sow thick, and to cultivate sorghum, just like beets, in such a way as to obtain the product of an average and suitable size.

From the field experiments they agree that—

1. The cultivation of sorghum, even in lands of moderate richness, succeeds very well in the same conditions as that of common maize, and when the chemico-industrial question is settled there will be nothing to fear in this direction.

2. The seed of acclimated sorghum gives a larger yield and a more vigorous plant than the original seed.

3. For the quantity of the yield sowing in line is preferable to sowing in tufts.

4. The yield of the stalks of the sorghum increases in quantity from the blossoming to the fecundation and the maturation of the seed; then it diminishes somewhat, and increases again after the autumnal rains.

5. In grounds tending to form a crust, the depth of planting must not be greater for sorghum than two centimeters, the depth of three centimeters having been found excessive even in the present case. Besides, as to the sowing, it is to be observed that it should not take place too early; it should be delayed until a stated season in the spring, from the first to the last of May. To sow earlier, with the unexpected return of cold, sorghum suffers, and in any event is injured considerably.

6. The enemies by which sorghum has been heretofore attacked are insects (which are easily destroyed by insect-powder made from tobacco) and birds. It is further to be observed, first, that whilst the leaf of the beet is often found injurious to animals fed upon it, causing among other things diarrhea, the sorghum leaf, on the contrary, makes good fodder; second, that the cultivation of the sorghum is more rapid and leaves the ground free sooner.

7. Likewise the grain of the sorghum furnishes a good food for cattle.

They found also, from further observations, that the percentage of sugar was somewhat higher than we have ever been fortunate enough to see. The results are presented in detail in my special report, together with such information from parts of our own country not already mentioned as were attainable under reliable circumstances.

LOSS OF SUGAR IN BAGASSE.

The loss of sugar in the bagasse through the unavoidable imperfections of milling have been already alluded to. It amounts to at least 25 per cent. and is often more. For sorghum cane the following exact data are at hand:

A mean of fifteen experiments, made in 1882, with single milling, gave 65 per cent. of juice from stripped cane. In nearly 300 tons of unstripped Amber canes ground during the season of 1883 at Washington, the weight of the expressed juice was 41.7 per cent. that of the cane.

In 48 tons of unstripped Amber canes ground during the past season at West Point, Ind., the weight of the juice was found to be 50 per cent. that of the cane.

In over 6,000 tons of Amber and Orange canes ground at Rio Grande, N. J., during the campaign of 1883, the percentage of juice expressed (double milling) varied from 40 to 55. At Champaign, Ill., 4,660 tons (half stripped) gave a yield of about 60 per cent. juice. Double milling was employed.

After a careful study of the data which have been accumulated, it is probable that not less than 40 per cent. of the total sugar present in the cane is lost in the bagasse. This is a waste far greater than true economy can permit, and in the following pages an attempt will be made to show the relation of the cane to juice extraction and to the process of diffusion.

The quantity of water contained in sorghum cane varies with the character of the cane and the kind of season in which it is grown. The results of experiments with Link's Hybrid cane will be given. This cane contained nearly 10 per cent. sucrose in its juice. To determine the water, the canes are cut into diagonal slices one-eighth inch thick. These are then placed in a thin layer in a copper chamber heated by steam to a uniform temperature of 100° C. (212° F.). After about fourteen to eighteen hours the chips suffer no further material loss of weight. They are then removed and their weight taken. Following are the results:

DRIED FOURTEEN HOURS AT 100°.	Per cent. moisture.
No. 1	76.38
No. 2	76.96
No. 3	76.31
No. 4	76.66
No. 5	78.18
No. 6	78.38
No. 7	77.94
No. 8	78.05
DRIED SEVENTEEN HOURS AT 100°.	
No. 9	77.62
No. 10	77.64
No. 11	77.21

	Per cent. moisture.
No. 12	77.54
No. 13	77.41
No. 14	77.23
No. 15	77.42
No. 16	77.30
No. 17	77.62
No. 18	76.96
Mean	77.38

From this table we learn that the water in a cane whose juice yields 12.5 per cent. total sugars is about 77 per cent. of the whole weight. An increase or decrease of sugar would probably affect the water more than any other constituent of the cane.

As a practical rule, therefore, we may safely assume that the per cent. of water in a sorghum cane is 77, plus or minus the difference between total sugars of expressed juice and 12.5.

For instance, when total sugars equal 15 per cent. the water would be $77-(15-12.5)=74.5$.

If total sugars are only 10 per cent. the water will be $77+(12.5-10)=79.5$.

An experiment to determine the water in a Louisiana cane, the juice of which had 15.5 per cent. sucrose and 1.25 of other sugars; total, 16.75, gave moisture 72 per cent.; calculated from foregoing rule, 72.75.

The sugar in the cane is contained in cellular tissue, the cells being grouped together like a honeycomb. The sugar is held in a state of solution in these cells by the water. The idea that sugar exists in the cane in a crystalline form is contrary to all rules of chemical physics and accurate observation. Cane sugar is completely soluble in about half its weight of water, and hence it could scarcely be crystallized in presence of six to seven times its weight.

The aqueous solution of the sugars in the stalk is either (1) contained within the cells, or (2) infiltrated in the cellular substance. The object of milling is, therefore, twofold (*a*) to break the cell structure and allow the liquids to escape, and (*b*) to press the cellular tissues and thus deprive them of their fluid contents. Evidently the greater the pressure the more perfectly the dehydration of the pulp will be. This pulp, however (of the same nature as blotting-paper), is exceedingly bibulous, and even after the liquids are forced out it will absorb them again as the pressure is removed. Again, no amount of pressure is able to produce a perfectly dry mass, and thus it comes that a large portion of the juice is usually left in the bagasse.

A practical question arises here, viz: Has the juice which is left in the bagasse a proportion of sugar different from that which is expressed?

The answers to this question have been so different that they have been subjected to the test of a series of analyses.

December 10–13, inclusive, five lots of sorghum cane, preserved in a silo, were subjected to analysis.

JUICE.

The mean percentage of juice expressed was	64.11
Bagasse	35.89
Eleven analyses of these mill juices gave (mean), sucrose	9.31
Seven analyses (mean), other sugars	2.18
Total sugars (mean) in juice	11.49

CANES.

The canes were cut into thin slices. About 40 kilograms were used for each sample and the chips well mixed.

Sucrose (mean of eighteen analyses)	8.64
Other sugars (mean of eight analyses)	1.92
Total sugar in chips (mean)	10.56

BAGASSE.

The bagasse, immediately after milling, was run through the cane-cutter, the chips well mixed and sampled for analysis.

Percentage of bagasse	35.89
Sucrose (mean of seventeen analyses)	6.17
Other sugars (mean of six analyses)	1.99
Total sugars in bagasse (mean)	8.16

From these analyses the following interesting facts appear:

(1) The ratio of the sucrose in the chips to that in the juice is 8.64:9.31, or 100 kilograms of cane contain as much sucrose as 92.8 kilograms of juice.

(2) The ratio of other sugars in the chips to those in the juice is 1.92 : 2.18, or 100 kilograms of cane contain as much uncrystallizable sugar as 88.1 kilograms of juice.

(3) The ratio of total sugar in the chips to that in the juice is 10.56 : 11.49, or 100 kilograms of cane contain the same amount of sugars as 91.9 kilograms of juice.

(4) The mean of sucrose in the bagasse was 6.17, or 2.21 per cent. total weight of the cane.

The total sucrose in the cane as determined by the sum of the analyses in the juice and bagasse was $9.31 \times .6411 + 2.21 = 8.18$ per cent.

(5) The mean of uncrystallizable sugar in the bagasse was 1.99, or .71 per cent. of the weight of the cane.

The total "other sugars" in the cane as determined by the analyses of the juice and bagasse were $2.18 \times .6411 + .71 = 2.11$.

(6) Total sugars as determined by analysis of juice and bagasse were $8.18 + 2.11 = 10.29$ per cent.; as determined by analysis of chips, 10.56. This is an agreement as close as could be expected from the difficulty of obtaining perfectly similar samples.

(7) The bagasse obtained as above, as shown by numerous experiments, contains about 69 per cent. of water and materials soluble therein and 31 per cent. cellulose and insoluble substances. In other words, the bagasse has still about 69 per cent. of juice, or 24.74 per cent of the weight of the cane.

(8) The composition of the juice remaining in the bagasse can be calculated as follows: Per cent. of juice, calculated on weight of cane, remaining in bagasse=24.7; per cent. of sucrose remaining in bagasse, 2.21 (weight of cane); per cent. of sucrose in juice remaining in bagasse $= 2.21 \div 24.7 \times 100 = 8.95$.

For "other sugars" we have the formula $.71 \div 24.7 \times 100 = 2.88$.

Therefore,

	Per cent.
Total sugar in bagasse juice	11.83
Total sugar in mill juice	11.49

These two numbers are so nearly the same that the logical conclusion is that there can be no great difference between the juice expressed by the mill and that left in the bagasse.

In this series of experiments it is true that the percentage of sucrose in the mill juice appears to be slightly greater than in the bagasse juice. For example, the ratio of sucrose to other sugars in the mill juice is 9.31 to 2.18, or 4.27 to 1. In the bagasse juice, by analysis, it is 6.17 to 1.99, or 3.10 to 1, and by calculation 8.95 to 2.88, or 3.11 to 1.

From these results we derive the following conclusions:

(*a*) The saccharine matter in the cane is evenly distributed through the juices of the stalk.

(*b*) Hence the juice remaining in the bagasse has the same saccharine richness as that expressed by the mill.

(*c*) But in the few experiments made the sucrose appears to be slightly in excess in the mill juice, and (*d*) the uncrystallizable sugar in the juice remaining in the bagasse.

The conclusions (*c*) and (*d*) are given subject to modifications from a more extended series of observation.

In a very large number of analyses no indications have been found of the existence of the sugar in the cane in a solid state, nor in any form of combination which would indicate an inequality in its distribution in the cane juices.

THEORY OF DIFFUSION.

If a solution of a crystallizable substance be separated from pure water, or a solution of the same substance of a different density, by an animal or vegetable membrane, an interchange will take place between the two liquids until they are practically of the same composition. This principle is called *osmose*. In a vegetable cell containing sugar in solution the flow of water inward is called *endosmose*, and that of the sugar solution outward *exosmose*.

The term crystalloids has been applied to those bodies tending to assume a crystalline shape, and colloids to those that have no tendency thereto. Crystalloids, however, possess this sensibility in different degrees. For example, solutions of metallic salts, such as those of potassium, respond to the osmotic force more readily than those of sugar. This difference is utilized in the construction of "osmogenes" apparatus, which are used in the beet-sugar industry to separate the potassium and other mineral salts from the sugar.

If vegetable substances containing sugar are cut into thin slices and exposed to the action of water, the sugar will pass out through the cell walls, and water flow in, until there is an even distribution of the sugar throughout the whole. If the external water is now drawn off, and a fresh portion supplied, the same phenomenon will be repeated. When this has been done eight or ten times the amount of sugar left in the cell is so small that for practical purposes it may be neglected.

MATHEMATICAL THEORY.*

Let n = number of cells in the battery.
a = volume of juice contained in the chips forming a charge for a single cell.
b = volume of liquid transferred from cell to cell.
g_0 = specific gravity of undiluted cane juice.
g_n = specific gravity of liquid in the rejected chips.
g_1 = specific gravity of diffusion juice.

Then

$$g_n = g_1 - (g_0 - g_1)\left\{\left(\frac{a}{b}\right)+\left(\frac{a}{b}\right)^2+\left(\frac{a}{b}\right)^3 \cdots\cdots \left(\frac{a}{b}\right)^n\right\}$$

* I desire to thank Professor Harkness, of the Naval Observatory, for this formula.

The specific gravity of the liquid remaining in the cane chips in each cell when the liquid from the adjoining cell enters, and also the specific gravity of the liquid entering and leaving each cell, may then be designated as follows:

No. of cell.	SPECIFIC GRAVITY OF LIQUID.		
	In cane chips.	Entering cell.	Leaving cell.
1	g_0	g_2	g_1
2	g_1	g_3	g_2
3	g_2	g_4	g_3
4	g_3	g_5	g_4
&c.	&c.	&c.	&c.
n	g_{n-1}	g_{n+1}	g_n

As the liquid entering any cell soon mixes with that contained in the chips therein, and reduces the whole volume of fluid to a uniform specific gravity, we have

$$g_1 = \frac{ag_0 + bg_2}{a+b} \quad . \quad . \quad . \quad . \quad (1)$$

Whence

$$g_2 = g_1 - \frac{a}{b}(g_0 - g_1) \quad . \quad . \quad . \quad . \quad (2)$$

and in general

$$g_n = g_{n-1} - \frac{a}{b}(g_{n-2} - g_{n-1}) \quad . \quad . \quad . \quad (3)$$

$$g_{n-1} = g_{n-2} - \frac{a}{b}(g_{n-3} - g_{n-2}) \quad . \quad . \quad . \quad (4)$$

$$g_{n-2} = g_{n-3} - \frac{a}{b}(g_{n-4} - g_{n-3}) \quad . \quad . \quad . \quad (5)$$

Substituting in (3) the values of g_{n-1} and g_{n-2} from (4) and (5), we get

$$g_n = g_{n-3} - (g_{n-4} - g_{n-3})\left\{\left(\frac{a}{b}\right)+\left(\frac{a}{b}\right)^2+\left(\frac{a}{b}\right)^3\right\} \quad . \quad . \quad (6)$$

The law governing the formation of the series is now evident, and its complete expression is

$$g_n = g_1 - (g_0 - g_1)\left\{\left(\frac{a}{b}\right)+\left(\frac{a}{b}\right)^3+\left(\frac{a}{b}\right)^3 \cdot\cdot \left(\frac{a}{b}\right)^n\right\} \quad . \quad . \quad (7)$$

This formula gives the relations between the specific gravities of the cane juice, the diffusion juice taken from the first cell, and the juice remaining in the chips when they are rejected; and it shows that so long as $g_0 - g_1$ is approximately constant, the smaller b is made with respect to a, the more efficiently the battery will work. If b is greater than a, the first cell will do most work, and each succeeding cell will do less and less; if b is equal to a, all the cells will work alike; and if b is less than a, the first cell will do least work, and each succeeding cell will do more and more. When it is remembered that the work of the first cell constantly

increases as b diminishes, the extreme importance of using the least possible quantity of water in the cells becomes evident. Indeed, the amount of water employed, and the value of $g_0 - g_1$, are the factors which determine the number of cells requisite to reduce the specific gravity of the liquid in the rejected chips to any given standard. In practice the number of cells employed has varied from six to eleven.

HISTORICAL.

The German chemist Margraff, who first detected the presence of sugar in the beet in 1747, attempted its extraction by a process similar to diffusion.

Dombasle, in 1842, made the first attempt to apply the principle of osmose to the extraction of sugar from vegetable cells, on a commercial scale.

Dombasle was led to believe from his experiments that the process of desaccharization could not be successfully carried on in the living cell (*i. e.*, fresh vegetable cells), but that it was first necessary to dry them or heat them to 100°, in order to destroy the life of the cell. This process he called "mortification."

On the beet roots, however, attempts to apply diffusion at a high temperature resulted in obtaining a viscous juice, with a great tendency to fermentation, and opposing considerable difficulties to crystallization. This trouble comes from the fact that water near the boiling point transforms the insoluble pectose, which exists in the beet in considerable quantities, into soluble pectine. It was this substance that exerted such an injurious influence on the juices.

From the researches of Dubrunfaut on "osmose and its employment in industry," the early workers of diffusion concluded that the exhaustion of the pulp was more easy, as its division was more minute; that the natural adherence of the cells, as well as the gases contained in the intercellular spaces, prevented the access of the diffusion fluid and resisted the double current of osmotic force.

It is true that after a certain time this force will overcome these obstacles without the temperature being raised high enough to produce mortification; but in this case secondary effects are produced, which interfere with the progress of diffusion.

Under these supposed disadvantages the process of diffusion languished, except when it was used to prepare the juice for the distilleries.

The problem was not solved until Robert, in 1864, by a series of experiments on a large scale at Seelowitz, in Moravia, proved that the former ideas were incorrect, and that the process of diffusion could be carried on at a temperature not above 40°, producing a juice of remarkable purity and quite free from pectine.

To show the superiority of the juice obtained by this method over that from the press, the following analyses are given:

	Press juice.	Diffusion juice.
No. I.		
Total solids	13.936	10.236
Of which, sugar	11.25	8.41
Ash	.603	.449
Organic matter	2.083	1.377

	Press juice.	Diffusion juice.
No. I—Continued.		
Then in 100 of sugar—		
Ash	5.36	5.339
Organic matter	18.516	16.373
Sum	23.876	21.712
No. II.		
Total solids	15.521	13.986
Of which, sugar	12.41	11.58
Potash and soda salts	.458	.441
Lime and magnesia salts	.187	.191
Nitrogenous organic matter	1.418	1.791
Non-nitrogenous organic matter	1.048	.983
Or for 100 parts of sugar—		
Potash, &c., salts	3.69	3.808
Lime, &c., salts	1.507	1.649
Nitrogenous, &c	11.426	6.830
Non-nitrogenous, &c	8.445	8.488
Sum	25.068	20.775

The success of the Robert's diffusion was so pronounced that the process became rapidly adopted among sugar fabricants, who are, perhaps, in some respects, the most conservative of all manufacturers.

In 1882 there were in operation in France five hundred and fifteen beet-sugar factories. Of these one hundred and two employed the process of diffusion. This rapid growth shows that the process is meeting in practice the theoretical advantages claimed for it.

Statistics are not at hand of the proportion of diffusion to press factories in other portions of Europe, but it is probably even greater than in France.

DIFFUSION APPLIED TO TROPICAL CANE.

In 1866, two years after Robert's success at Seelowitz, Mr. Minchin applied the diffusion process to sugar-cane at Aska, Province of Madras, East Indies. With the most primitive apparatus and under the greatest difficulty the experiment was undertaken. The diffusion cells were built of wood, and the cane-cutter was a disk of wood covered with sheet iron.

In spite of these difficulties M. Minchin was able to exhibit samples of diffusion cane-sugar at the Paris Exposition of 1867, and received a gold medal.

Encouraged by the success of the Aska experiment, attempts were made to introduce the process into Louisiana. In a pamphlet entitled "The Robert Diffusion Process Applied to Sugar-Cane in Louisiana in the years 1873 and 1874," a detailed account of these experiments is given. This is so interesting that I will make a few extracts from it.

In the spring of 1869, Dr. Canisius, formerly United States consul at Vienna, came to New Orleans with powers from Mr. Julius Robert, the patentee for the United States, to introduce this new process here in New Orleans. He had the reports of the Aska Company since 1866, and thought it a very easy matter to convince our planters of the advantages of adopting it at once. He was astonished, at first, at the indifference he met with in New Orleans, which astonishment was changed into disgust after an unsuccessful tour through the sugar par-

ishes. Chagrined and disappointed he left for the West. Two years later, in 1871, a Mr. Wessely, from New York, came here on the same errand and with the same authority from Mr. Robert's general agent, Mr. Adler, in Vienna. He had no better success than Dr. Canisius, and in a much shorter time he became convinced of the fruitlessness of his efforts.

If, so far, no progress had been made towards the introduction of the diffusion process in Louisiana, these efforts were yet destined to bear fruit. Parties in New Orleans took the pains to investigate closely all the results obtained by this new process, and its adaptability to this country. Mr. R. Sieg brought all his capacity and influence to bear on this subject, and by German perseverance has this day the satisfaction of having succeeded. It cannot be omitted here to state that he was principally actuated by the motive of benefiting the State of Louisiana and his adopted country, the United States, as the success of this enterprise would make them independent of the sugar of any other country, Louisiana, Florida, Alabama, and Texas being fully capable of producing all the saccharine matter needed for the whole country. In Louisiana alone there are 1,000,000 of acres of the best sugar land thrown out of cultivation, which, with a yield of 1,000 pounds to the acre, would increase the production by 1,000,000 hogsheads. It is certain that the moment the cultivation of these lands with cane becomes profitable to such a degree as the working of this new process has demonstrated, the enterprise and capital of the whole Union will not be wanting.

Late in the season apparatus and engineers arrived in New Orleans, and with all exertions it was not possible to begin the test before the 18th of December, 1873. Ten enormous vessels, 8 feet high and 6 feet in diameter, had to be carried through the breadth of Europe, shipped on a steamer in Bremerhaven, landed in New Orleans, reshipped on steamboat, landed at Donaldsville, reshipped on a raft or flat on the Bayou La Fourche, landed at Belle Alliance (Kock's plantation), and erected in their places near the sugar-house. It was necessary to construct a building four stories high for a diffusion house, on whose first floor were the diffusion vessels; on the second story, the diffusion room; on the third story, the cane-cutters and movable carriage to fill the vessels; and on the fourth story the cutters were fed by taking the cane from the old carrier and throwing it by hand into the cane-cutters on the story below. Only the most dogged perseverance surmounted the obstacles of the unskilled labor not only, but also of the adversity of the season; but a whole year was at stake, and the trial had to be made that year, and was made.

This process consists in a peculiar mode of extracting the sugar from the vegetable matter in the cane without mechanical power.

If sugar-cane is cut into thin slices and covered with water for some time, an exchange of the liquid contents of the cane and the surrounding water will take place. After a certain time the water will contain the same percentage of dissolved sugar as the cane itself. By the usual method of crushing the cane the cellular structure of the membrane is destroyed, and the albumen and other mucilaginous impurities are thereby permitted to enter into the cane juice.

Again, the greater quantity of cells containing saccharine matter being in the center of the cane, by pressure the free exit of the saccharine matter is prevented, it having to pass through the surrounding thick fibrous cells.

In the diffusion process, the slices are brought into immediate contact with the diffusive liquid.

The advantages of this process of obtaining the saccharine matter from the cane over the old one by pressure are:

1. Greater amount of saccharine matter obtained from the same amount of cane.

2. The juice is only slightly charged with impurities and needs, therefore, less defecation.

3. No receiving boxes needed, less skimmings and no settlings.

4. The cane may be rich, healthy, or old, sour, frost-bitten, windrowed, yet all the amount of saccharine matter in it will be obtained in a comparatively pure condition.

With the apparatus worked, the following result was obtained as described by Mr. Sieg:

The cane at disposal had been frost-bitten twice. The first time on the 24th of October, and the second time, a month later, on the 23d of November. It had been windrowed since the end of November, and presented a very bad appearance, so that fully one-third had to be cut off and left in the field, that third being more or less rotten.

Work began on the 18th of December, 1873, and was finished with five interruptions of more or less duration, owing to the holidays and other causes, on the 3d of January, 1874.

The cane was carefully weighed under the superintendence of Mr. Archibald Mitchell, of Leeds & Co., in this city, and in presence of any chance visitor. On 40 arpents, or 31.80 acres, there was obtained in all 957,600 pounds of cane for the cutters, which makes an average of 28,730 pounds per acre. The juice pressed from the same cane weighed 6.66° Beaumé. The average weight of the single canes for the cutters was 2 pounds.

The juice coming from the diffusers and going into the clarifiers weighed 5.56° Beaumé.

The total amount of juice obtained was 84.39 pounds from 100 pounds of cane, the latter containing 90 per cent. of juice; therefore a loss of only 5.61 pounds of cane juice. The best results obtained from the rollers showed a loss of 24 pounds of juice from 100 pounds of cane under the most favorable circumstances.

From the clarifiers it went through five open kettles, was boiled down to 25° Beaumé, and went from thence to the vacuum pan in the usual way.

The amount of saccharine matter obtained was as follows:

31.8 acres, at 28,750 pounds cane per acre	pounds cane..	957,600
31 hogsheads net production of sugar	pounds..	35,736
139 barrels molasses, 5,542 gallons, one gallon molasses at 12 pounds	do...	66,504
Total of pounds of sugar and molasses		102,240

which makes, on 957,600 pounds of cane, 10.67 per cent. of sugar and molasses.

The great preponderance of molasses over sugar is due to the deteriorated condition of the cane, and to not having made second and third sugars.

For the purpose of comparison, the results obtained this season with the old process by Messrs. McCall Brothers and Col. Amedée Bringier are annexed.

Five hundred and sixty-nine acres of cane, 28,051 pounds, at 7 to 8° Beaumé. Total amount of cane rolled, 15,961,384 pounds. Result ob-

tained, 440 hogsheads, at 1,150 pounds each. Total amount of sugar, 506,500 pounds; 1,000 barrels of molasses, at 43 gallons, 12 pounds per gallon, equal to 516,000 pounds. Sugar and molasses, total, 1,022,500 pounds.

The production of saccharine matter was 6.40 per cent. of the cane worked. Now, if the result obtained had been the same as that by diffusion, 10.67 per cent. (from very inferior and deteriorated cane, the juice of which weighed only 6.66 Beaumé), the result would have been, sugar and molasses, total, 1,703,079 pounds, which is a surplus gained of 680,579 pounds. To sum up, if the cane on Messrs. McCall's plantation had been worked by diffusion, and would have had only the same weight of Beaumé, 6.66, and had deteriorated besides, the result obtained would have been 293 hogsheads of sugar and 665 barrels of molasses, more than was obtained under the old process.

Col. Amedée Bringier stated that he had chosen the finest cane on his place in order to test as exactly as possible how much could be obtained by one of the best mills in the State, and one of the most economically-conducted sugar-houses. Fifty-one acres, at 57,794 pounds per acre, are 2,947,500 pounds; the cane juice weighed 8° Beaumé.

Production of sugar	pounds..	135,272
Production of molasses	do....	74,976
Total green sugar		210,248

Or 7.13 per cent. of saccharine matter to cane worked.

The great preponderance of sugar over molasses in this result is due, first, to the good condition of the cane; secondly, and principally, to superior handling and working of the cane juice after leaving the rollers.

Assuming he had obtained the result gained by the diffusion process, he would have had 314,498 pounds of sugar and molasses, which is a surplus over this result of 104,250 pounds; or, calculated in the same proportion as his relative quantities of sugar and molasses—total surplus sugar, 67,364 pounds; also surplus molasses, 36,866 pounds.

As a matter of special interest, the report of Mr. Ludwig Kollman, technical director of these experiments, is here given:

On this place the weight of the cane was carefully registered during our work; the quality of the cane was tested from time to time by passing a few canes through a small set of hand-rollers and the juice weighed with a very delicate saccharometer. During this our first week's run, the analyses of the mill juice and diffusion were as per table following:

To avoid all misapprehension it must not be forgotten that for every 100 gallons of mill juice we had 113 gallons of diffusion juice, which accounts for the apparent higher rating by saccharometer in mill than in diffusion juice.

Analysis of mill and diffusion juice.

Constituents.	Mill juice, specific gravity, 1.05746.	Diffusion juice, specific gravity, 1.04620.
	Per cent.	*Per cent.*
Crystallizable sugar	11.80	9.65
Glucose	1.68	1.38
Foreign substances	0.62	0.42
Saccharometer per cent., Balling	14.10	11.45

During the first week of our work there were 987,945 pounds of cane cut. This cane contained 90 per cent. of juice, of which 83 were sent to the clarifiers; therefore obtained (calculating by the analysis above given):

	Per cent.
Crystallizable sugar	8.81
Glucose	1.25
Foreign substances	0.46

The loss of juice by clarification, skimmings, and sediments in sirup tanks amounts to about 6 per cent. on the weight of the juice, or 4.98 per cent. on the weight of the cane; therefore, amount of juice really obtained in green sugar, 78 per cent. on the weight of the cane. Of this 8.28 per cent. crystallizable sugar, 1.17 per cent. glucose, 0.43 per cent. foreign substances.

According to the established analysis, every pound of foreign substances in cane juice prevents the same amount of sugar from crystallizing; and furthermore, through the influence of great heat, long continued in open kettles, a further amount of crystallizable sugar is converted into uncrystallizable sugar. To be on the safe side, double the amount of glucose would represent the disturbing element in crystallization of the sugar contained in the diffusion juice, the perturbing action of the heat included. Under these circumstances we ought to have had, in dry substances, 6.68 per cent. of crystallizable sugar, 3.20 per cent. of molasses.

To compare the above with the results obtained in our run, it will be necessary to reduce the amount of dry substances to the same basis.

	Per cent.
The amount of water in the sugar is	1.50
The amount of glucose and foreign substance	0.75
The amount of water in the molasses	20.00

This would give us 6.83 per cent. sugar, 3.78 per cent. molasses. Total, 10.61 per cent., against 10.37 per cent. actually obtained, showing a loss of 0.24 per cent., which has to be charged to profit and loss, attributable to want of control in the sugar-house.

ABSTRACT FROM REPORT OF FIRST WEEK'S RUN BY DIFFUSION, OCTOBER 26 TO OCTOBER 31.

Sugar-cane worked up	pounds..	987,945
Saccharometer:		
Density of mill juice	per cent..	14.10
Density of diffusion juice	do....	11.45
Yield of undiluted juice on the weight of the cane	do....	82.92
Sugar obtained:		
First product:		
Hogsheads		29
Pounds		35,595
Second product:		
Hogsheads		14.5
Pounds		16,111
Total in pounds		51,706
Molasses obtained:		
Barrels		100
Gallons		4,249
Pounds		50,778
Total sugar and molasses	pounds..	102,484
Percentage of sugar on the weight of the cane		5.234
Percentage of molasses on the weight of the cane		5.139
Total percentage		10.37
Excess of diffusion products over mill products	per cent..	42.5

The difference of 1.60 per cent. in the yield of sugar is due to the fact that our seconds did not have sufficient time to granulate and to settle, consequently much of the sugar of small grain passed through the centrifugals into the molasses, as proved by the analyses of the said molasses, showing far more per cent. of sugar than it should have had.

ANALYSIS OF MOLASSES.

Dry substances by saccharometer	79.92
Water	20.08
Crystallizable sugar	63.82
Glucose	12.38
Foreign substances	3.72

It appears from the report made by Mr. B. D. Seghers that on the second run of diffusion we came very near obtaining the proper proportions of sugar and molasses.

To show the comparative yield of the mill and diffusion processes, the table taken from Dr. Kratz's report is given:

Comparative table as to yield.

Process.	Duration.	Quantity cane consumed.	Products.		Sugar.	Molasses.	Total.
			Sugar.	Molasses.			
	Days.	*Pounds.*	*Pounds.*	*Pounds.*	*Per cent.*	*Per cent.*	*Per cent.*
Mill run	6	1,386,730	57,743	43,170	4.164	3.113	7.277
Diffusion first	6	987,945	51,706	50,778	5.234	5.139	10.373
Diffusion second	5	915,515	54,549	38,752	5.958	4.233	10.191

Process.	Surplus.			Cost of manufacturing 1,000 pounds sugar and molasses.	Against diffusion for 1,000 pounds sugar and molasses.	Cost of 1,000 pounds, including cane at $5 per ton.	Dry substances.	Dry substances.
	Sugar.	Molasses.	Total.					
	Per cent.	*Per cent.*	*Per cent.*				*Pounds.*	*Per cent.*
Mill run	....	....	....	$12 53	....	$46 88	90,276	6.51
Diffusion first	25.7	65.1	42.54	15 10	$2 57	39 20	90,284	9.14
Diffusion second	43.0	35.98	40.0	13 82	1 29	38 35	83,764	9.15

It will be seen, by studying carefully the above table, that owing to better manipulations on the part of all employés the relative quantities of crystallized sugar was very much increased in this run over the first run, and, financially considered, still better in comparison to mill run than our first run had been.

The total percentage of sugar and molasses in this run appears to be less than in the first, but in reality it is about the same, because it must be remembered that sugar contains from 1 to 3 per cent. of water, and molasses from 20 to 25 per cent., and in the above figures this water is "counted in," as it always is in commerce.

In spite of this most pronounced success of the diffusion process, it has not been introduced into Louisiana, and, so far as I know, has not extended beyond these original experiments. I append a letter which

I sent to Mr. R. Sieg, of New Orleans, whom I have to thank for many favors in the preparation of this report, and his answer thereto:

DEAR SIR: I desire to thank you for copies of the "Sucrerie Indigène," containing articles by M. Riffard on the diffusion process applied to sugar-cane in Aska. If you have leisure and inclination, will you kindly answer the following questions:

1. Has the diffusion process been tried in Louisiana any further than indicated in Dr. Kratz's report?
2. How many factories in the State are now using this process?
3. How do you explain the indifference with which the planters generally regard the process?

With your permission I desire to publish the answers which you may give. I will return the copies of the "Sucrerie" as soon as I have done with them.

Respectfully,

H. W. WILEY,
Chemist.

R. SIEG, 26 *North Charles Street, New Orleans, La.*

NEW ORLEANS, *December* 15, 1883.

DEAR SIR: Before replying to your questions in detail you will permit me to give you a short outline of the situation of the sugar industry in Louisiana, as we found it in 1873, when we introduced the diffusion process in this State.

We were then still sharing the common belief of our planters, that they could and did, with their more powerful mills at least, extract from 70 to 72 pounds of juice out of every 100 pounds of cane. We only hoped to increase this, by diffusion, to 84 to 85 pounds, so that by adopting the process our planters should gain about 20 per cent.

You may, therefore, judge how great must have been our surprise when, by the use of scales, by the measuring of the juice, and by the usual polariscopic tests, we ascertained beyond a doubt that only a very few mills in this country did extract more than 55 to 58 pounds of juice; that instead of obtaining only 20 per cent. more juice by diffusion, the yield was really increased from 40 to 50 per cent., and that this juice, in spite of the various defects in our primitive machinery, with its unavoidable irregularities and delays, had rather gained than lost in purity.

The discovery of these important facts made, of course, a deep impression upon our planters, and if our apparatus and some of its accessories had been as perfect as they should have been, and as inexpensive as they could be made at present, diffusion would have superseded every other means of extracting the juice from the cane, just as it has done this now in the modern beet-sugar industry.

Unfortunately, the first apparatus which we imported from Europe had been the one used by Mr. J. Robert, the inventor, and his father before him, in their original experiments, and it was handed over to us by the latter, as if for the purpose of getting rid of it. Of course, after using it in our first short trial, we, too, concluded that it was utterly useless for the diffusion process in general, and its application to cane in particular.

Subsequently our mechanics tried their skill upon the improvement of the apparatus, designing one, which in some respects was perhaps a trifle better; in other respects, however, even less good than the first one had been.

We only gained one point with it—through the reduction of its dimensions the apparatus worked faster. But the much desired and promised economies in labor as well as in cost of construction were really not attained. Consequently, when our sugar-planters inspected our work in 1874-'75 they readily jumped at the conclusion that a superior and more reasonable apparatus could not be devised, and these two objections were, for a time at least, fatal to the process. And then the same mechanics who at the beginning had helped to advance the cause of diffusion, having lost their pecuniary interest in it, joined the opposition from rival inventors to pull it down.

Strangely enough, the same observation has recently been made regarding one of the greatest concerns of Paris, which was criticised for having done a similar service to the sugar manufacturers of their country, by influencing them to use some costly patent presses; and to this circumstance as much as to any other the inferiority of the French sugar industry of to-day was rightly or wrongly principally attributed.

Another objection was also made, viz., that diffusion would give our planters such an amount of juice that with their former and even present means of evaporation they would be entirely incapable of keeping up with the extraction, and that in consequence thereof they could be compelled to work either slower, consuming less cane per day, or to throw their juice away, as they now do, by leaving it in the bagasse.

After looking very carefully into this last-mentioned objection and finding that it was quite correct, and that out of our 1,200 sugar-houses not more than 16 or 18 had evaporators deserving the name, while the sugar-houses blessed with these had been

erected many years ago by the celebrated Mr. Rillieux, I became convinced that the open kettles were the greatest insurmountable impediment to every serious progress in our sugar industry, and that without radically changing this system of evaporation, or rather of toasting the juice, the discussion of increasing its volume would be either useless or premature.

Having pegged at this obstacle for a number of years without intermission, I had at last the satisfaction to see that our planters commenced to move in the matter, and that these old clumsy things, the kettles, were turned out of a goodly number of sugar-houses. Now, at least, our planters might do more work, and having once entered upon the road to real progress, it might be hoped that they would not stop at the open steam-pans, the next worst evaporator known, and long since set aside by all sugar manufacturers who were in the habit of using the polariscope and examining the losses or changes which their products suffered through faulty treatment in the course of manufacture.

Thinking that these perhaps a little too lengthy remarks were necessary to render my answers more intelligible and just to all concerned in the matter, I will now pass on to your questions.

"1. Has the diffusion process been tried in Louisiana any further than indicated in Dr. Kratz's report?"

Yes; the two old apparatus constructed in 1874 were moved to a plantation in Saint Charles Parish the year after, for the purpose of demonstrating the great advantages of the central-factory system for the manufacturing of sugar. As the plantation was low and only suited for rice, a large amount of cane had been brought from distant plantations situated on the banks of the Mississippi River, and it was calculated that the cane might be economically transported by old coal-barges towed up and down systematically. The season, however, being exceptionally late, the cane did not mature before the middle of November, and the unripe cane, which had been cut and for days left at the landings, and on the barges also, exposed to the weather, suffered considerably from these unforeseen and unavoidable delays. Experience then and since has proven that it is not advisable to transport large masses of cane by water, and where this mode of transportation is still employed, the barges or vessels should never load more cane in one day than could be delivered from them at night or the next day.

After the poorest lots of cane had been worked up, the yield exceeded a percentage of 8 per cent. in first and second sugars several times, notwithstanding the very unsatisfactory arrangement of the purgery, its coolers, &c. At that time the sugar-wagons now used were an unknown convenience, in our sugar-houses at least.

In 1876, a good year, and 1877, the worst we ever had, the same old machinery was again set to work upon a much smaller quantity of cane, mostly produced on the plantation, but no records were kept or obtainable.

The plantation had no cane crop in 1878, but in 1879 a small experiment was again made under my supervision; but as the sugar-house had been run down by the parties who preceded us, I could only convince myself that even under the most adverse and wretched conditions diffusion would still be greatly superior to mill work, because, notwithstanding the dilapidated condition of the diffusers, which, if properly made, should have lasted forever, and in spite of many delays and stoppages which ought not to occur, we averaged about 81 per cent. of normal juice from 100 pounds of cane.

The lower part of our old diffusers consisted of a large cast-iron box of a triangular shape, intended to make the opening for the discharge of the diffusion-bagasse as large as possible. This arrangement proved to be the most awkward in practice, while in principle or theory, fully borne out by experience, it was perhaps the most improper one that could have been selected. Besides this, the large iron castings riveted together, which formed this part, would crack or leak, and thereby rob the apparatus of one of its principal merits, to-wit, that of not being subject to breakages or repairs. But while this part of the apparatus had to be condemned entirely, its upper portion, comprising the valves and pipes, also required so many alterations that it would have been cheaper to make the whole thing new than to attempt remodeling it.

In this connection it may, perhaps, not be amiss to observe that a simpler, better, and, in every respect, more perfect apparatus might now be constructed for about one-third of the money which our old ones had cost us, and cheapness, as well as perfection, is one of the greatest desiderata to our Louisiana sugar industry.

"2. How many factories in the State are now using the process?"

None. The only thing that our planters had seen of diffusion, in the way of a practical demonstration, was our first, by far too expensive, and, moreover, so complicated apparatus, that they very naturally felt as if such a thing would never do for the work upon their plantations, and in this I think they were perfectly right; consequently, it would have needed another ocular demonstration to prove that the difficulties in constructing a better, more labor-saving apparatus, had been exagger-

ated and overcome. But the planters themselves were not willing to make such an experiment at their expense, and, there being no one else who seemed to be either inclined or capable of doing it for them, the thing remained undone.

In 1879, however, our Sugar Planters' Association again took notice of the process, and appointed a committee, consisting of Messrs. Dymond, Godberry, and Laplace, three prominent planters, who, after affording me the pleasure of showing them a sketch and the workings of a modern diffusion apparatus, suitable for sugar-cane, appeared to be quite satisfied, and concluded their subsequent report as follows: "The dearly learned lessons of the past bid fair to so improve diffusion, as applied to sugar-cane, that the cane planters adopting it shall so increase their yield and so diminish their expenses that they will be able to hold their own against this European giant, grown suddenly so great and strong that he now seems about to crush the cane-producing world out of existence."

"3. How do you explain the indifference with which the planters generally regard the process?"

Our planters do not regard the process with indifference, but have in general not a very clear conception of the whole matter. The majority of all sugar-houses in Louisiana are already so deficient in evaporation, that if the crop happens to be a little larger, or the season be shortened by sudden changes in the weather, the planters are immediately exposed to the danger of losing a part of their crop in the field, and as this has already not unfrequently occurred with an extraction of merely two-thirds of the juice, it would of course happen more frequently still if something like 50 per cent. more juice was thrown upon their sugar-houses, unless their capacity for evaporation should be very nearly doubled, so as to provide against every contingency. Our planters generally have an idea that good evaporators are much more expensive than bad or inferior ones; but this is a mistake. At all events the introduction of good evaporators is of still more pressing necessity even than the increase of the extraction. If diffusion had no other merit than to force our planters to improve their evaporation—and it has done this in Europe—it would be one of the greatest blessings that could be conferred upon our sugar industry. This subject, however, is so vast and far-reaching in its relations to this great industry that I could not hope to do it justice in a few passing remarks like the present. Suffice it to say, that evaporators such as those which our planters are now getting at a comparatively great expense, can no longer be seen, except in some of the most superannuated and poorly arranged sugar factories of Europe or in the antiquated sugar-houses of tropical countries.

In this respect the sugar-planters of the Hawaiian Archipelago are setting us an example worthy of imitation, for, notwithstanding their great natural advantages, they seem to be ever anxious and ready to take hold of every improvement or progress which the cane-sugar industry has been or is on the point of making. I was therefore not much astonished to learn that the other day these planters had listened with particular attention and favor to a proposition submitted to them with a view of inducing their Government to appropriate $50,000 or $60,000 for the importation from Europe of a diffusion apparatus and other machinery necessary to the establishment of an experimental station, at which the process could receive a complete and thoroughly scientific test. Considering the great influence which these sugar-planters have, and the great services which their industry has rendered to their Government, it could scarcely deny them a favor so insignificant in comparison to the object in view.

But the planters of the Sandwich Islands are not alone in their endeavor to advance their industry as much as they can; the sugar-planters of Cuba are also earnestly thinking of improving especially their present unsatisfactory methods of juice-extraction, and from information lately received I believe that they too intend to give the process a fair trial next season. The necessity for these improvements is imposed upon them by the recent abolition of slavery, by the growing scarcity of labor, and by the nevertheless declining value of their products. It seems, therefore, quite certain that our planters also can no longer trust in the natural or artificial advantages of their position, and that, on the contrary, they ought to use every available means to economize in their expenditures, in their raw material and labor, so that they too may be able to resist any further encroachments upon the value of their crops and productions.

Most respectfully,

R. SIEG.

Prof. H. W. WILEY, *Washington, D. C.*

EXPERIMENTS MADE IN GUADALOUPE.

The next account of experiments made with diffusion on sugar-cane is in a communication by M. Edmond Riffard to the "Sucrerie Indigène," published in the numbers for 19th and 26th of June and 18th of

September, 1883. According to the observations of Riffard on tropical cane, the mean content of sugar is 15.3 per cent. in the juice, or 13.77 per cent. of the total weight of cane. There is expressed by double milling with intermediate saturation of the first bagasse with hot water an amount of saccharine matter represented by the following figures:

Per cent. juice expressed by first mill	60
Per cent. juice expressed by second mill	25

equal to 11 per cent. of normal juice. Total per cent. normal juice expressed, 71. Each 100 kilograms of cane, therefore, furnished 71 kilograms of juice, or $\frac{71\times15.3}{100}=10.86$ kilograms of sugar. But 100 kilograms of cane contain $\frac{100\times13.77}{100}=13.77$ kilograms of sugar. The sugar lost in bagasse, therefore, is $13.77-10.86=2.91$ kilograms.

The total amount of sugar lost in the molasses is .75 kilogram; and in manufacture, .86 kilogram; and total sugar obtained, 9.25 kilograms.

This is certainly a favorable showing for mill work, and yet these are the results which led Riffard to make the experiments with diffusion.

In sorghum the best yields of sugar heretofore obtained on weight of cane have been 3 to 3.5 per cent. We would certainly be satisfied if this could be raised to 9.25.

DIFFUSION OF THE BAGASSE.

Riffard made some experiments with the bagasse, although I think it hardly proper to call them experiments with diffusion. When the cells are crushed, as in the bagasse, *maceration* is a more appropriate term. The bagasse was chopped in a straw-cutter and placed in diffusion-cells holding 73 kilograms each. In all, 950 kilograms were used. The amount of diffusion juice obtained was 3.8 hectoliters; of wash water, 5.4 hectoliters. Reduced to the basis of the density of the juice as it comes from the mill, this gave 53.93 per cent. of the weight of the bagasse, or 21.57 per cent. of the weight of the cane. It is thus seen that by double milling 71 per cent. of juice is obtained, and 21.57 by diffusion of the bagasse, giving a total content of 92.57 per cent. of juice in the cane.

The following is the summary of the experiments made with bagasse:

1. The bagasse must be cut into small pieces before it is subjected to diffusion.
2. In this condition the bagasse readily submits to the process.
3. The products of diffusion calculated as normal mill juice amount to about 22 per cent. of the weight of the cane.
4. With rapid work the purity of the juice will be equal, if not superior, to that of the second milling.
5. The system of the "long battery" is the one to be adopted.

These are valuable results. They show that it would pay to institute the process of diffusion in connection with milling.

One of the great objections to the introduction of diffusion has always been that it would result in the practical loss of the milling machinery already in operation. But from these experiments it appears that the process can be established in connection with milling, and then when the mills break or wear out the diffusion machinery will be ready to take their place.

DIFFUSION OF CANE.

M. Riffard also reports some experiments of diffusion applied to cane, from which I will make a few quotations:

The canes were cut into rondelles, having a thickness of 2 or 3 millimeters. In the first experiment 725 kilograms of rondelles were subjected to diffusion.

The volume of juice obtained was 4.40 hectoliters, specific gravity 1.056; of wash water, 4.60 hectoliters, specific gravity 1.025; equal to 2 hectoliters, specific gravity 1.056; total volume of juice, 6.40 hectoliters.

Calculated for normal mill juice, this gave a yield of 84.9 per cent.

Two other experiments were made.

A comparison of these with the product obtained from milling the same cane is seen in the following table. The diffusion juice is calculated in terms of normal mill juice:

Comparison of juices of diffusion and milling.	Mill juices.			Diffusion juices.		
	First milling.	Second milling.	Mean.	A.	B.	C.
Density	1.063	1.046	1.056	1.066	1.060	1.064
Sugar per hectoliter	14.74	10.97	13.30	15.82	14.38	15.10
Uncrystallizable sugar	1.04	0.67	0.89	0.85	0.92	1.09
Purity coefficient	87.6	87.3	87.4	88.43	88.29	87.00

It is seen by the above that the process of diffusion has notably increased the yield of sugar, although it is evident that the extraction was not complete. Only 84.9 per cent. of juice was obtained, and 92—84.9= 7.1 per cent. remained in pulp.

FURTHER EXPERIMENTS AT ASKA.

From the report of Mr. Riffard, something further of the success of the Minchin works, already mentioned, at Aska, was learned.

ANALYSIS OF ASKA CANES.

A mean of the analysis of various parts of the cane gives the following as the composition of the entire stalk:

Cellulose	8.20
Water	76.94
Sugar and soluble matters	14.86

The canes show a considerable difference in composition in the upper, lower, and middle thirds. This is shown in the following analysis:

An average lot of canes.

Constituents.	.608 meter of the top.	.608 meter of the center.	.608 meter of the butt.
Cellulose	7.63	8.47	8.30
Sugar	10.63	13.31	13.37
Glucose	2.64	1.51	1.54
Salts	3.07	0.259	0.233
Water	78.334	75.612	76.122
Undetermined	0.459	0.839	0.455

In Louisiana canes the difference is even more striking, but it does not seem to appear in sorghum canes. From the Agricultural Report for 1881 and 1882, page 463, I quote a table and paragraph illustrative of the above.

Table showing relative value of different parts of sugar-cane stalk.

Constituents.	Butt.	Middle.	Top.
Sucrose .... per cent..	15.36	12.95	3.21
Glucose .... do....	.75	1.42	3.68
Solids .... do....	.24	.68	2.23
Available sugar .... do....	14.37	10.85	—2.70
Specific gravity	1.068	1.061	1.038

From the above results there would seem to be in the immature sugar-cane top a close resemblance to the immature stalks of sorghum, and yet the analogy ceases as soon as the sorghums have attained a full maturity, for, as the results of very many analyses show, there is practically no difference in the juice from the upper or lower half of the sorghum stalks.

From his experiments Mr. Minchin is led to believe that—

A capacity of from 25 to 30 hectoliters appears to us as the most favorable for the cells; their emptying and cleaning are thus rendered easy, the cane yielding its juice with ease. The temperature is to be maintained at 90°-95° C. We are assured by analysis that no inversion takes place in these conditions of temperature.

In the two experiments below, performed with great care, the temperature of the entering juice, measured at the calorisator, was 90° C. (mean).

Number of cells.	Duration of process.				Density of the outflowing juice at 28° C.	
	A.		B.		A.	B.
	H.	*M.*	*H.*	*M.*		
1		25		15	1.020	1.020
2		15		15	1.037	1.032
3		10		10	1.050	1.047
4		15		10	1.055	1.055
5		10		20	1.056	1.063
6		10		10	1.066	1.068
	1	25	1	20		

It is seen that at the sixth cell the maximum density corresponds to that of normal juice. All stoppage of the work of the battery, the aeration of the juices, their cooling, are to be avoided. Juices which are not obtained by lime defecation, whatever be their origin, are changed at the temperature of the air; the lime with which they are commonly alkalised is an illusory preservative. If the battery is operated in the condition of temperature indicated, the juice will flow out with a light amber tint and with a remarkable limpidity. Any lack of transparency indicates a lowness of the temperature of extraction.

Such has been the history, as far as it has been possible to trace it, of the application of diffusion to tropical cane. The process has not spread with the rapidity which characterized its introduction into the sugar-beet industry and which its merits warrant. But what has been done is of the utmost value for comparison with the experiments I have made in its application to sorghum, and which will now be given in detail.

DIFFUSION APPLIED TO SORGHUM.

The following were the problems proposed in the experiments:

1. To devise suitable apparatus.
2. To determine percentage of saccharine matter extracted.

3. To determine percentage of saccharine matter left in pulp and waste water.
4. To compare diffusion juices with mill juices from same kind of cane.
5. To establish best proportion of water to use.
6. To determine influence of time and temperature on percentage of juice extracted and its properties.

APPARATUS.

The apparatus for the experiments in diffusion was constructed in New York. It consists of two parts, viz., the cane-cutter and the diffusion battery.

THE CANE-CUTTER.

This machine consists of a cast-iron disk, conical in shape, and carrying three knives shaped like the bit of a carpenter's plane. The canes are delivered to the cutter by a forced feed, set to move at such a rate that the canes are advanced from one-eighth to one-sixteenth of an inch during each third of a revolution of the disk. The canes being fed parallel to the axis of the machine, are struck by the knives in the conical disk at an angle of about 35°, *i. e.*, the angle of inclination of the cutting surface of the disk to the axis.

The disk revolves 500 to 800 times per minute. Each revolution represents three-eighths to three-sixteenths inch of canes cut. The rate of movement of the canes, therefore, is 187 to 300 inches per minute. The knives are easily detached, when dull, and sharp ones put in their places. The knives should be ground twice a day and sharpened with an oilstone every two hours.

The dimensions of the experimental cutter are:

Diameter of disk	feet..	2
Thickness of disk	inches..	1¼
Angle of inclination of disk		35°
Diameter of shaft	inches..	2¼
Length of shaft	feet..	4
Diameter of pulley	inches..	13
Capacity for ten hours	tons..	3.5 to 4

The disk was covered by a hood, so that the chips could not be thrown into the room. These were received by a box underneath. This apparatus at first gave some trouble on account of the feed, which was not properly arranged. When this was adjusted, however, the machine worked well. A cane-cutter properly constructed will always have an advantage over a cane-mill, viz., it will be difficult to break it or get it out of order. On the other hand, cane-mills are a constant source of trouble, and often by untimely breaking entail great loss on the manufacturer.

Instead of having the knives shaped as in the cutter just described, it would probably be better to have them thinner. The thick knife tends to break the chip into several pieces in lines parallel to the axis of the cane, but this may not be a disadvantage. It certainly exposes a greater surface to the action of the diffusion juices. It may, however, by the rupture of a greater number of cells, tend to defeat the idea of diffusion, which is percolation through unbroken membranes. The substance of the cane being much more brittle than that of the beet, it will be found quite impracticable to secure for the diffusion process chips as perfect as the *cossettes* and *schnitzel* of the French and German factories.

CAPACITY OF CUTTERS.

It may be objected to the method under discussion that it would not be practicable to construct machines to work on a large scale, say from two to four hundred tons of cane per day. Judging from our experience with the small mill and the experiments carried on in Louisiana, to which reference has already been made, such an objection seems untenable. For equal weights of cane a cutter will, if properly constructed, be lighter and require less power to run it than a mill. All cane-workers should be willing to give a fair hearing to the claims of a machine which will relieve them from the worry and expense of the choking, breaking, and creaking of the mills.

DIFFUSION BATTERY.

This machine consists of eleven cells arranged in such a way that a liquid from any one of them can be transferred to another, either from the top or bottom of the cell, at will. The cells are 30 inches long, 12 inches in diameter, and hold about 10 gallons. On one side is the system of tubes and valves by which the process of filling and emptying is carried on. On top of the cells are the openings through which they are filled with the freshly-cut chips. Each cell ends below in an opening set obliquely to its axis, through which the exhausted chips are discharged.

On the side opposite the feed-valves is found the steam supply by which the cells or the liquid contained in them can be heated either from above or below. This heating should take place in separate compartments, which in large apparatus are called calorisators. The water is forced through the cells by the ordinary pressure of the Washington water-works, which here is scarcely equal to the pressure of two atmospheres. The water as it flows to the cells passes through a heater, where it can be brought to any desired temperature.

MANIPULATION.

The first cell having been filled with chips and the openings all closed except the air-valve at the top, water from the heater at a temperature of 60° C. (or other desired degree) is admitted through the bottom of the cell until it begins to flow out through the air-valve at the top. This vent is now closed, and the valves changed so that the water enters from the top of the first cell. The second cell is now filled with the liquid from the first, which has meanwhile become charged with all the sugar it is capable of taking from the first chips. The valves are so arranged that the liquid from the first cell is forced out by the fresh water entering from above, and into the second cell from below until this is filled. The third cell is now brought into action in the same way, the fresh water entering through the top of the first cell, the valves having been changed for the second cell so that the liquid from the first flows in at the top of the second, forcing its contents out and up through the third cell. This process continues until nine cells have been filled.

By this time the chips in the first cell, having been treated with nine successive portions of fresh water, have lost all but the merest trace of their sugar. This cell is therefore shut off from all the others, the fresh water is turned on to the second cell, and while the tenth cell is filling the first one is emptied of its exhausted chips.

The fresh water is next turned on the third cell, while the eleventh one is filling. Meanwhile the first cell is prepared for the second

charge of fresh chips, and the process now goes on regularly, nine cells being always in use and two being filled or emptied.

RESULTS.

Careful analyses were made during the process of the experiments to determine the completeness of the extraction and the character and quality of the diffusion juices, and to compare them with the juices of the same canes obtained from the mill. The diffusion cells held 18.2 kilograms (40 pounds) of chips. This quantity was weighed and put in each cell. The cell, after being filled with chips, would still hold nearly 22 kilograms of water (48 pounds). The exhausted chips were found to have increased in weight, so that each cell-full weighed nearly 22 kilograms. The charge and discharge of the cell, therefore, are represented by the following table:

	Kilograms.
Weight of chips taken	18
Weight of exhausted chips	22
Weight of diffusion juice drawn off	22
Weight of waste water	22
Per cent. diffusion juice to weight of chips	122

Each 100 parts chips gave of juice 122 parts.

INCREASE IN VOLUME OF DIFFUSION JUICE OVER MILL JUICE.

A large number of experiments has shown that the total content of juice in the cane is 89 per cent. (nearly). Of this amount about 85 per cent. are extracted by diffusion. Whence it follows that a mill which would extract as much of the saccharine matter as diffusion would give, for each 100 parts cane, 85 parts; by diffusion, for 100 parts cane, 122 parts; or 100 parts mill juice are represented by 143.5 parts diffusion juice. It thus appears that the amount of evaporation required for diffusion juice is a little less than one-half more than that required for mill juice. Nearly 180 experiments made this year with diffusion have shown that only about one-half of one per cent. of sucrose is lost in the pulp and waste water. Let us take, therefore, for instance, as an illustration a cane containing 12 per cent. sugar:

100 kilograms of this cane contain of sugar	kilograms..	12
Loss, .5 per cent	do....	2.5
Sugar obtained by diffusion	do....	9.5
Per cent. sugar obtained by diffusion		80
100 kilograms of cane contain of juice	kilograms..	89
Obtained by mill	do....	50
Per cent. obtained by mill		55
Per cent. sugar obtained by mill		6.6
Per cent. sugar obtained by diffusion		9.5
Per cent. sugar gained by diffusion		2.9
Per cent. sugar gained to total sugar		24

Thus allowing a liberal loss of sugar in diffusion, and taking a fair average result of single milling, we find a gain of 24 per cent. in sugar.

We will compare this theoretical result with one obtained in actual practice:

*Experiments in diffusion run of November 9, 1883.**

Cane diffused	kilograms..	990.00
Juice obtained	do....	1,210.00
Waste water	do....	1,210.00
Pulp	do....	1,210.00

* Boiled to semi-sirup on this date and to melada several days later.

Per cent. of sucrose in diffusion juice	4.73
Per cent. of other sugars in diffusion juice	2.12
Per cent. of total sugars in diffusion juice	6.85
Weight of total sugars obtained ... kilograms	82.89
Per cent. of sucrose in pulp	.27
Per cent. of other sugar in pulp	.06
Per cent. of sucrose in waste water	.03
Per cent. of other sugar in waste water	.07
Per cent. of total sugar in pulp and waste water	.43
Weight of total sugar lost ... kilograms	5.32
Total sugars in 990 kilograms cane ... do	88.21
Per cent. of total sugars obtained	93.97
Per cent. of total sugars lost	6.03

It is thus seen that out of 100 parts of sugar in the cane on November 7, 93.97 parts were obtained. Compare with this the result of the (theoretical mill work)—

Weight of juice from 990 kilograms (50 per cent.) ... kilograms	495.00
Weight of juice not obtained ... do	386.00
Per cent. of juice (and saccharine matters) extracted ... do	57.3
Total sugar in 990 kilograms cane ... do	88.21
Of which obtained by the mill ... do	54.85
Total sugar lost ... do	33.36
Per cent. of total sugar obtained ... do	62.39
Per cent. of total sugar lost ... do	37.61
Per cent. of total sugar lost by diffusion ... do	6.03
Gain by diffusion ... per cent	31.58

It appears from the data of the analytical work that the gain in sugar by diffusion over ordinary milling is from 25 to 30 per. cent., and over double milling from 15 to 20 per cent. Until November 14 it was impossible to use the small vacuum pan which had been procured for these experiments, and therefore the results in *masse cuite* and sugar could not be kept separate. On November 14 the following data were obtained:

Analyses.

Diffusion juice, November 14:	
Specific gravity	1.0406
Sucrose	6.04
Other sugars	2.16
Purity	67.5
Total solids	9.05
Mill juice, same cane and date:	
Specific gravity	1.065
Sucrose	9.95
Other sugars	3.29
Purity	64.4
Total solids	15.13
Melada obtained, 196.4 kilograms (by diffusion):	
Per cent. sucrose	52.50
Per cent. other sugars	20.85
Weight of chips diffused ... kilograms	1,596
Weight of juice obtained ... do	1,929
Weight of sucrose in *masse cuite* ... do	103
Percentage of *masse cuite* to cane ... do	12.28

LOSS OF SUGAR.

The pulp from the 1,569 kilograms of cane weighed 1,929 kilograms. It contained .12 per cent. sucrose, and .06 per cent. other sugars. Then $1,929 \times .0008 = 1.54$ kilograms of sugar lost in waste water. Total loss in both, 5.01 kilograms.

The *masse cuite* obtained above is well crystallized, but the crystals are so small and the proportion of gum so great that it has not been possible to purge it easily in the centrifugal.

Another trial was made on Tuesday, November 20, of the same kind of cane as above (Link's Hybrid), which had been frozen on the preceding Thursday, and left since that time lying in the yard.

Run of November 20, 1883.

	Kilograms.
Weight of chips diffused	1,447.8
Weight of juice obtained	1,738
Weight of pulp obtained	1,738
Weight of waste water obtained	1,738
Weight of semi-sirup	276.3
Weight of *masse cuite*	157.8

Analyses November 20, 1883.

Samples analyzed.	Sucrose.	Other sugars.
Chips	7.68	3.38
Mill juice	9.58	3.70
Diffusion juice	5.63	2.50
Pulp (exhausted chips)	0.10	0.06
Waste water	0.026	0.027
Semi-sirup	28.94	12.58
Masse cuite	48.83	22.15

RESULTS.

Percentage of *masse cuite* to cane diffused=10.9.

Total weight of sugar in diffusion juice was 1,738 ×.0813=141.30 kilograms.

Total weight of sugar in pulp was 1,738 ×.0016=2.77 kilograms.

Total weight of sugar in waste water was 1,738 × .00053=0.92 kilogram.

Total weight of sugar in cane=141.30+2.76+.92=144.98 kilograms.

Total loss in diffusion 3.69 kilograms.

Per cent. of loss in diffusion 3.04.

Total weight of sugar in semi-sirup was 276.3 × .4152=114.72 kilograms.

Loss during evaporation to semi-sirup was 141.30—114.72=26.58 kilograms.

This loss was due to wastage, scum, and especially to the sediment and gum separated during defecation and which could not be filtered.

MASSE CUITE.

Total weight of *masse cuite*, 157.8 kilograms.

Total weight of sugar in *masse cuite*=157.8×.7079=112.0 kilograms.

Loss in reduction from semi-sirup to *masse cuite*=114.72 —112.01=2.71.

The total loss of sugar during evaporation was 2.99 + 2.71=5.70 kilograms, or nearly 5 per cent. of the weight of the *masse cuite*. This practical result conforms to the experience of the beet-sugar manufacturers, who always allow for 5 per cent. loss in boiling.

CONCLUSIONS.

The experiments in diffusion, it must be admitted, are far from being satisfactory; a great deal, however, can be learned from acquiring a practical idea of the nature of the defects in any new process. The following seem to be the chief faults in the experiments made:

(1.) We aimed to secure a diffusion juice of about the same density as the diffusion juice from the beet as obtained in the European fac-

tories. It is now apparent that this was a mistake. If a mill juice shows a density of 1.062, a diffusion juice should have one of not less than 1.050. In fact the volume of the diffusion juice should represent a weight not greater than that of the canes diffused. The average ratio of the weight of the cane to that of the diffusion juice in the experiments was not far from 100 : 125. It is true that in localities where coal can be obtained for $20 a carload, a very dilute juice is not so objectionable, from a merely economical view. On the otherhand, if the juice is first to be concentrated in open pans, its dilution becomes a very serious matter. The liability to inversion on long boiling is too well known to need any additional emphasis here. But there are many localities where coal is dear and evaporating capacity limited. In such places the production of a juice as dilute as that represented in the foregoing tables would be a fatal objection to the process.

It is difficult to see how such dense juices are obtained as those mentioned in the experiments in Guadaloupe. In quite a number of my experiments the water was allowed to remain ten minutes in contact with each cell of chips, or ninety minutes in all for the contents of each cell. Yet the highest specific gravity obtained even by this method was 1.0473, as shown in Analysis 141, Table I.

There are three factors in the problem of the application of diffusion to sorghum which demand a more careful study, viz., (*a*) time, (*b*) temperature, and (*c*) pressure.

(*a*) For nine cells two hours at a mean of 60° C. would not probably be more than sufficient to secure the mean density desired.

It is apparent now that the diffusion juices were not allowed to remain long enough in contact with the chips. The chief objection to allowing a longer time for diffusion is found in the tendency to fermentation, which these dilute juices possess in the highest degree. This objection would be fully met by the uniform practice of introducing into each fresh charge of warm water some antiseptic like lime bisulphite or carbolic acid. Another objection is found in the increased time required to complete the extraction. This, however, can be met by increasing the size of the diffusers.

(*b*) There is no doubt of the fact that osmosis in vegetable cells will take place more rapidly as the temperature of the ambient fluid rises. Thus a more rapid extraction of the sugar will take place if the temperature be kept at a higher degree. On the other hand as water approaches a boiling point it dissolves any starch granules which the cells may contain, and transforms the insoluble pectose into soluble pectine, and brings into solution any other difficult soluble bodies which the chips may contain. It has been noticed, morever, at these high temperatures that the outflowing juice is highly colored, and has a peculiar odor which indicates the solution of some odoriferous bodies not dissolved by a colder liquid.

(*c*) This method works well and has none of the disadvantages which characterize the others. It has been noticed that, when by means of a system of steam-pipes with which our battery was supplied, a pressure of three or four atmospheres was produced for a few moments on each cell, the degree of exhaustion was much greater than when only the ordinary pressure of the water, amounting to less than two atmospheres, was employed. The sorghum-cane is more compact than tropical cane, and will require more care in diffusion.* Pressure appears

* This is shown by the slow increase in density of the diffusion juices, and also by some mill experiments, in which I found that Louisiana canes would yield about 4 per cent. more juice than sorghum under the same conditions.

to be the most promising aid in securing a greater density. But there is no reason to hesitate in combining all three of these proposed methods of securing a heavier product in case any one alone should fail. The best way of all to have secured a denser juice would have been to use a less quantity of water. It is probable, from a study of the analytical data, that the proper weight of water to use would be equal to the weight of the chips diffused. In this way, if all the other conditions of manipulation were properly attended to, a juice of 1.05 specific gravity would be secured from canes giving a mill-juice of 1.06.

(2.) The discrepancy which exists between the data furnished by the analyses and those obtained by the weight of the cane diffused and juices obtained is the most unsatisfactory result of the work done.

It appears from the analyses that the total sugars left in the chips and lost in the waste water are—

	Sucrose.	Other sugars.
Pulp	.468	.159
Waste water	.094	.102
Sum	.572	.271

In all, .843 per cent. The total sugars in the canes worked was $13.12-(13.12\times.11)=11.68$ per cent., and the per cent. of sugar extracted (by analysis) is $(11.68-.843)\div11.68=92.78$. According to the record of weight and measurement kept at the sugar-house, the total percentage of sugar extracted was about 85. In the two days' run, when the juice obtained was boiled separately in a small vacuum pan to *masse cuite*, the weight of the melada obtained was, in round numbers, 11 per cent. of the cane. This shows that the results of the analyses were borne out by the amount of melada obtained.

It would be fair, in giving a summary of the work, to base it on a mean of these two sets of results. We prefer, however, to take the lower numbers as a basis, as much injury may be done by generalizing on a few good results and taking no account of those of an inferior order.

SUCCESS.

Respecting the success which attended the experiments, the following statements may be made:

(1.) The extraction of at least 85 per cent. of the total sugars present was secured. In many of the experiments, as will be seen by consulting the table, scarcely a trace of sugar could be detected in the exhausted chips.

(2.) The production of a quantity of melada represented by from 10.9 to 12.28 per cent. of the weight of the cane diffused.

This was secured with a cane in which the total sugars did not exceed 11.68 per cent. The percentage of melada by this process will be found just about equal to the per cent. of total sugars in the cane.

It ought to be greater with a more perfect extraction, but we are speaking only of results actually obtained.

This yield is just about double that obtained by the large factories at Rio Grande, Champaign, and other places.

(3.) The production of a juice of great purity, which lends itself easily to processes of depuration.

The experiments, however, have their chief value in the fact that they will call the attention of cane-growers to the advantages which a rational system of diffusion will have over pressure in the extraction of the saccharine matter. In the present condition of the sorghum-sugar industry, in which it has alike to be protected from the over zeal of its friends and the opposition of its enemies, the process of diffusion offers the most promising outlook for success. It therefore seems the duty of this Bureau to make a more practical test of this process and on a larger scale.

Of the sugar industries of the country, as a whole, it may be said that they are far from being on a successful financial basis. Of the two canes, tropical and sorghum, it may be said that the processes of manufacture are imperfect and wasteful. A large part of the sugar is left in the bagasse, and another large part passes into the molasses.

Of the two northern sources of sugar the beet has the advantage in localities suited to its growth, since the methods of manufacture are so thoroughly complete and the conditions of their successful working so well understood. With this source of sugar, therefore, the problem narrows itself to the growth of a good beet.

With sorghum the future success seems to depend on the following conditions:

(1.) A careful selection and improvement of the seed with a view of increasing the proportion of sucrose.

(2.) A definition of geographical limits of successful culture and manufacture.

(3.) A better method of purifying the juices.

(4.) A more complete separation of the sugar from the canes.

(5.) A more complete separation of the sugar from the molasses.

(6.) A systematic utilization of by-products.

(7.) A careful nutrition and improvement of the soil.

With the present extremely low prices of sugars, all these conditions must be most carefully guarded before a profit can ensue, and it will be the object of this division not only to investigate the subject on their own part, but to keep informed as to the results of others.

MAPLE SUGAR.

The remaining source of sugar, the maple, is necessarily limited in the amount which it can furnish. Of the products but little has hitherto been known, and having been requested by Prof. H. C. Bolton to furnish him with copies of analyses of maple sugars and sirups, it was surprising to find how small an amount of attention had been given to the matter. In order to arrive at a more definite idea of the constitution of these products, a large number of samples were purchased in open market and others secured directly from reliable manufacturers.

The results of the analyses, presented in the following tables, show to be true what has long been suspected, namely, that the commercial articles are largely adulterated. The commercial sirups are quite uniformly mixed with starch-sugar, or glucose. No method of analysis, however, will detect a kind of adulteration, which is probably common, that of the addition of cane or beet sugar to the maple. All of these sugars are identical chemically.

Of the sirups, Nos. 14 to 20, inclusive, are known to be genuine. Excluding from these No. 15, which had been made for more than a year and had undergone, undoubtedly, partial fermentation, it is seen that the sucrose varies from 39.22 per cent. to 64.45 per cent. The invert

sugar (glucose), on the other hand, varies from .21 per cent. to 3.24 per cent. The percentage of water is, as an average, astonishingly large, over 30 per cent.

Of the sugars, Nos. 15 to 20, inclusive, are known to be genuine. In these the sucrose is quite constant, about 84 per cent., while the invert sugar varies between .80 and 5 per cent. The water is much higher, too, than one would expect.

Another year it is intended to extend the investigation.

MAPLE SIRUPS.

No.	Sucrose by double polarization.	Invertose.	Water.	Ash.	Undetermined.	Total.	Description and remarks.
1	50.49	9.90	32.39	.33	6.89	100.00	Thurber's mountain sirup, quart bottles, bought in Washington, D. C.
2	22.94	27.77	25.06	.58	23.65	100.00	Vermont maple sirup (McClary), quart bottles, bought in Washington, D. C.
3	63.57	trace.	31.52	.69	4.22	100.00	Vermont sirup, kept in bulk, bought in Washington, D. C.
4	57.94	5.52	29.14	.44	6.96	100.00	Do.
5	61.25	trace.	29.68	.74	8.33	100.00	Do.
6	32.07	32.79	19.01	1.00	15.13	100.00	Western Reserve (Block Bros.), half-gallon cans, bought in Washington, D. C.
7	57.71	3.24	31.34	1.14	6.57	100.00	Western Reserve (Block Bros.), kept in bulk, bought in Washington, D. C.
8	61.41	1.58	28.72	.82	7.47	100.00	Hazen's Vermont sirup, quart bottles, bought in Washington, D. C.
9	63.78	2.00	26.69	.84	6.69	100.00	Ohio sirup, from Mr. LaDow, Washington, D. C.
10	49.46	17.24	33.98	.38	......	101.06	Ohio sirup, kept in half-gallon cans, bought in Washington, D. C.
10	49.13	....	....	......	......	....	
11	29.41	17.57	33.66	.86	18.50	100.00	Do.
11	29.25	....	....	......	......	....	
12	64.26	.66	31.28	.74	3.06	100.00	Hazen's Vermont sirup, in quart bottles, bought in Washington, D. C.
12	64.18	....	....	......	......	....	
13	44.54	16.00	40.26	.79	......	101.59	Sirup made from butternut tree, from Franklin B. Hough, New York.
13	....	....	40.12	......	......	....	
14	62.23	.21	35.21	.55	1.80	100.00	Maple sirup, from Franklin B. Hough, New York.
14	62.35	....	35.19	......	......	....	
15	42.09	17.54	33.74	.95	5.68	100.00	Maple sirup made in 1883, from M. J. Smith, Middlefield, Mass.
15	42.16	17.24	33.72	......	......	....	
16	54.80	3.24	38.58	1.03	2.35	100.00	Maple sirup made from last run of sap in 1884, from M. J. Smith, Middlefield, Mass.
16	55.02	3.24	38.65	......	......	....	
17	63.87	1.39	32.11	.71	1.92	100.00	Maple sirup made in middle of season 1884, from M. J. Smith, Middlefield, Mass.
17	63.79	1.38	....	......	......	....	Do.
18	64.45	1.39	31.67	.76	1.73	100.00	Do.
18	64.45	1.39	....	......	......	....	Do.
19	62.90	1.78	32.84	.68	1.80	100.00	Maple sirup made early in season of 1884, from M. J. Smith, Middlefield, Mass.
19	62.79	1.82	....	......	......	....	Do.
20	39.22	1.79	36.72	.94	21.33	100.00	Maple sirup made in 1883, from M. J. Smith, Middlefield, Mass.
20	39.22	1.79	....	......	......	....	

MAPLE SUGARS.

1	84.24	6.33	8.03	.31	1.09	100.00	In bulk, bought at Washington, D. C.
2	81.67	9.26	8.84	.97	......	100.74	Do.
3	79.08	6.02	11.57	.91	2.42	100.00	Do.
4	71.80	12.19	9.73	.70	5.58	100.00	In small cakes, bought at Washington, D. C.
5	86.27	5.91	6.77	.76	.29	100.00	Do.
6	86.52	trace.	8.63	1.06	3.79	100.00	In bulk, bought at Washington, D. C.
7	80.22	6.89	8.68	1.30	2.91	100.00	Do.
8	86.24	4.54	7.82	.41	.99	100.00	Do.
9	84.58	1.11	9.74	.96	3.61	100.00	Do.
10	84.51	3.22	8.24	1.26	2.77	100.00	Do.
11	85.42	.87	8.78	.67	4.26	100.00	Do.
12	84.14	6.57	7.47	.49	1.33	100.00	Do.
12	83.97	....	....	......	......	....	Do.
13	85.68	.48	10.81	1.21	1.87	100.00	Do.

MAPLE SUGARS—Continued.

No.	Sucrose by double polarization.	Invertose.	Water.	Ash.	Undetermined.	Total.	Description and remarks.
13	85.33	....	....	......	......	....	In bulk, bought at Washington, D.C.
14	85.13	2.23	6.83	1.50	4.31	100.00	Do.
14	84.81	....	....	......	......	....	Do.
15	84.72	.80	9.53	1.21	4.54	100.00	Sugar made early in season of 1884, about March 20, from M. J. Smith, Middlefield, Mass.
15	85.86	.83	9.51	......	......	....	Sugar made early in season of 1884, in small cakes, from M. J. Smith, Middlefield, Mass.
16	82.36	2.10	10.75	1.25	3.54	100.00	Sugar made early in season of 1884 from M. J. Smith, Middlefield, Mass.
16	82.96	....	10.74	......	......	....	Sugar made early in season of 1884, in small cakes, from M. J. Smith, Middlefield, Mass.
17	86.97	1.69	7.68	1.06	2.00	100.00	Sugar made early in season of 1884, from M. J. Smith, Middlefield, Mass.
17	86.36	....	7.25	......	......	....	Sugar made early in season of 1884, in small cakes, from M. J. Smith, Middlefield, Mass.
18	86.28	2.10	7.59	1.27	2.76	100.00	Sugar made early in season of 1884, from M. J. Smith, Middlefield, Mass.
18	86.74	2.09	7.12	......	......	....	Sugar made early in season of 1884, in bulk, from M. J. Smith, Middlefield, Mass.
19	86.89	2.08	7.96	1.06	2.01	100.00	Sugar made from the last run of sap in April, from M. J. Smith, Middlefield, Mass.
19	86.96	....	7.69	......	......	....	Sugar made from the last run of sap in April, in bulk, from M. J. Smith, Middlefield, Mass.
20	82.07	5.00	9.26	1.16	2.51	100.00	
20	82.15	4.85	8.63	......	......	....	

MILK AND BUTTER.

The thorough study of the chemistry of the dairy products of the country is a matter to which I would call your special attention. Analyses of milks, butters, and cheese, carried on in a fragmentary and desultory manner, although valuable, are not definitions.

To fix the standard of American milk and butter it will be necessary to carry on the investigations under one direction in various parts of the country. I urge, therefore, the necessity of securing a special appropriation for this purpose, in order that this Bureau may be able to establish branch laboratories in noted dairy localities in the various parts of the country. The advantages of such a systematic study will be at once apparent both to producer and consumer.

As an introduction to this work many analyses of milk and butter have been made, chiefly with a view to developing the best methods and processes for the more extensive work which is to follow.

The outline of the work already done will be given below.

American Butters and their Adulterations.

PRELIMINARY STUDY.

In undertaking an extended examination of American butters and their adulterations the Department of Agriculture has in view three principal objects:

(1) To compare the constitution of American butters known to be pure with those produced in other countries.

(2) To determine the influence of breed, care, varieties, and quantities of food upon the constitution of butter.

(3) To discover the percentage of adulteration and the character of the adulterants.

METHODS OF COLLECTION.

Two methods of collection are employed, viz., (*a*) purchase in open market, and (*b*) from reliable dairymen.

It is evident that by the first method it will be easy to arrive at the percentage of adulteration, especially when it is considered that these purchases will be made in various parts of the country and under the operation of several State laws bearing on the manufacture and sale of butter surrogates.

By the second method samples will be secured which will give accurate data of the composition of genuine butter.

This research at the present time acquires additional interest from the fact that the manufacture of butter substitutes has reached in this country large proportions, and seriously affects the interest of that large class of our agricultural people who are engaged in the dairy interest. Even if the butter substitute be as wholesome and palatable as the genuine article, and if it be sold under its proper name, as is, indeed, generally the case, yet it tends to overrun the market and thus cheapen the price of real butter.

METHODS OF EXAMINATION.

WATER AND CURD.

The content of butter in water varies within wide limits. This is due to many causes, but chiefly depends on the treatment of the butter subsequent to churning. It is the practice of some to "work" the butter after churning only enough to roughly incorporate the salt. In this way much water and curd are retained. Others wash the butter well to remove the curd, and thus a butter poor in curd and rich in water is obtained. Still others—and this is the proper method—wash well to remove the curd, and then work well to remove the water, or expel the latter in a centrifugal. This treatment produces a butter poor in water and curd. The amount of water which a good butter should contain should not exceed 12 per cent.

In 19 butters, as seen by the following table, the highest percentage of water is 14.31, and the lowest 7.34.

ESTIMATION OF WATER.

I have found this best done by using a flat dish of porcelain or platinum 6. c. m. in diameter. The bottom of the dish is covered with pure sand to the depth of nearly 1 c. m.

About 5 g. of butter are taken and the dish is heated in an air-bath at 100°–105° for two hours. If the fat is taken in bulk without sand it is very hard to expel the last drops of water from the dish, but this can be accomplished by stirring in a few c. c. of absolute alcohol.

This latter method is to be preferred when it is desired to estimate the curd in the same sample, as will be mentioned further along.

It is too early yet in the investigation to fix a standard of water content which shall be the limit of a good butter.

Foreign analysts have found in some instances the percentage of water to be above 25. It is generally acknowledged by these chemists that 12 per cent. water is a just limit beyond which a good butter ought not to go.

Perhaps it would be somewhat arbitrary to say that more water than this would indicate a useful adulteration, but manufacturers should not

send their products to market until the water has been reduced to 12 per cent. or less.

CURD.

I have tried many ways to estimate the curd. To filter the butter through paper washed with ether or naptha, and wash the curd into a tarred dish, dry and weigh, ignite and deduct weight of ash, I have found unreliable.

To filter through a Gooch crucible and proceed as above (without washing) is better, but a very slow process. Moist fat, even dissolved in ether, filters with difficulty through a Gooch. To fill the crucible partly with sand helps the process, and is a moderately good method.

Fair results are obtained by using a tarred filter and weighing the curd, after drying, on the filter. After ignition, the weight of the salt is to be deducted, and percentage of curd determined.

Better still, and the best method found, is to dry in porcelain or platinum dish without sand. The dish should have a small stirring rod, be heated for two hours at 105°, stirred every twenty minutes. If drops of water are still seen on bottom of dish, a little absolute alcohol is to be stirred in and the dish reheated. Ether or naphtha is then to be added, and the solution filtered through a Gooch crucible. All the curd is to be carefully washed into the crucible with an ether wash bottle, crucible dried for an hour at 105°, and weighed. This gives total weight of salt and curd. From this deduct the weight of salt, determined as hereafter described. Remainder equals weight of curd.

CASEIN.

Curd is composed essentially of casein. I have thought, however, that if the real amount of albuminous matter present could be determined it would be more useful than to know the total amount of curd. With this purpose in view, there was made a series of determinations by combustion with soda-lime and by moist combustion with alkaline solution of permanganate of potassium.

The numbers obtained are in the following columns:

Number.	With soda-lime; per cent. of albuminoid.	With permanganate of potassium; per cent. of albuminoid.
1	.602	.843
2	.728	.703
3	.601	.553
4	.675	.703
5	.657	.636
6	.714	.620
7	.800	.938

From these results it is seen that the two methods, while not giving identical results, nevertheless present an agreement as close as could be expected from the character of the manipulations.

In the soda-lime process about five grammes of the butter were taken. The amount of gas evolved during the combustion was very consider-

able. Great care had also to be exercised in mixing the butter with alkali and in the combustion.

In the moist combustion about 300 mg. of the butter were taken and distillate nesslerized in the usual way. The moist combustion process is much to be preferred, as far as manipulation and economy are concerned, and the results seem equally reliable.

SALT.

Salt has been estimated in two ways, viz., (*a*) the usual process of filtration and combustion, and (*b*) by washing out the salt with hot water and titrating it with a standard solution of silver nitrate, using potassium chromate as indicated. This latter process gives good results, and repeated analyses show fair agreement.

About 5 g. of the butter are placed in a bulb separating funnel and shaken with successive portions (50 c. c.) of hot water. After this the subsidence of the water it is drawn off. It will be found that five washings will remove all but a trace of the salt. It is then directly titrated with the silver solution. The following duplicate numbers show the reliability of this process. When it is remembered that the salt is often put in butter in lumps of considerable size, the agreement is all that can be desired:

Table of the duplicate analyses of salt.

No.	Articles.	Lowest.	Highest.	Average.
1	Dairy butter	1.99	2.05	2.03
2	......do	2.52	2.58	2.55
3	......do	1.76	1.76	1.76
4	......do	1.23	1.23	1.23
5	......do	1.64	1.64	1.64
6	......do	1.64	1.64	1.64
7	......do	2.11	2.11	2.11
8	......do	2.81	2.81	2.81
9	......do	3.22	3.33	3.28
10	......do	1.87	2.05	1.96
11	......do	2.87	2.93	2.90
12	......do	2.75	2.81	2.78
13	Creamery butter	4.39	4.50	4.45
14	......do	2.52	2.58	2.55
15	......do	5.10	5.15	5.13
16	......do	2.28	2.34	2.31
17	Tub butter	3.80	3.86	3.83
18	......do	3.63	3.63	3.63
19	......do	1.93	1.99	1.96
20	Oleomargarine	3.98	4.05	4.03
21	......do	3.28	3.34	3.31
22	......do	2.81	2.81	2.81

SATURATION EQUIVALENT.

The saturation equivalent is the amount of potassium or sodium hydrate necessary to saponify a given weight of the fat. The fat is prepared for saponification by melting, allowing curd, salt and water to subside, and filtering. An approximate semi-normal solution of the alkali in alcohol is employed for the saponification. The alcohol employed should be previously filtered through bone black, otherwise the solution will be too highly colored for delicate titration.

The saturation equivalent is expressed in abstract numbers obtained by dividing the molecular weight of the alkali employed by the number of milligrammes of it used in saponification. The numbers for the two hydrates thus become the same.

It appears from the table that the saturation equivalent is an almost certain test of pure butter. Its range in the analyses made is from 249.5 to 239.8, while in the oleomargarine it rises to 284.7.

MANIPULATION.

The dried and filtered butter fat is weighed in a small beaker with a 2 c. c. pipette. Five stout half-pint clear glass beer bottles with patent rubber stopper are provided. Into three of these two c. c.s of the melted fat (35°) are run, the beaker and pipette being weighed each time, so as to secure the exact weight of fat taken. Into each of the five bottles are now run 25 c. c. of the alcoholic potash solution. The bottles are then stoppered and placed on steam bath, being shaken every five minutes until the fats are saponified. When the bottles are nearly cool they are opened, and 1 c. c. phenolphthalein solution (*e. g.* to 250 c. c. alcohol) run in.

They are now titrated with semi-normal hydrochloric acid until neutral. The two blanks give the strength of the alkali solution, and the three bottles of fats show how much of the alkali had been neutralized in saponification. The following table shows the results of this process in the butters already analyzed:

Triplicate and duplicate determination.

No.	Saturation coefficient.			
	1.	2.	3.	Mean.
1	245.0	245.3	244.7	245.0
2	244.9	245.0	244.9	244.9
3	245.3	244.6	244.6	244.8
24	284.6	284.8	284.7	284.7
4	245.9	246.3	....	246.1
6	247.2	247.0	....	247.1
7	246.5	246.3	....	246.4
14	247.1	246.4	....	246.7
15	245.6	244.8	....	245.2
16	244.6	244.2	....	244.4
17	243.7	244.1	....	243.9
18	244.4	244.1	....	244.2
19	249.2	248.7	....	248.9
20	283.8	284.1	....	283.9
21	282.4	282.6	....	282.5
23	280.0	280.0	....	280.0

SOLUBLE AND INSOLUBLE FAT ACIDS.

The best proof of a pure or adulterated butter is in the relative proportion of soluble and insoluble acids which it contains. A first-class butter fat may have as high as 7 per cent. soluble acid, while the average may be placed at 5 per cent. On the other hand, the adulterants used in butter and the substitutes therefor will be found to contain only 5 per cent. or less of soluble acid. It may be granted that no unadulterated butter will contain less than 4 per cent. soluble acid, while the limit might well be placed at 4.5 per cent. without excluding any desirable genuine butter. The estimation, therefore, of the soluble acid is an argument convincing alike to the chemist and the court whenever the purity of a butter is called in question.

There is nothing particularly novel in the method which has been employed in the present work, but a brief summary of it will be given.

MANIPULATION.

The butter fat is run out of a 5 c. c. pipette, as in the process for saturation equivalent. Of the alkali solution 50 c. c. are used. Blanks are made as before, except that the alcohol is evaporated off before the titration is made.

When the fat is saponified the contents of the bottles are washed into large assay flasks. These are placed over the steam-bath and allowed to remain until the alcohol has all been driven off.

The amount of semi-normal acid necessary to saturate the alkali in the blank tests is now accurately determined, and this amount is then run into the flasks containing the soaps. Generally about 1 c. c. more acid is added than is necessary to set free the fats; but this is not necessary.

Hot water is then added, 100–200 c. c., the flask stoppered (with a long glass tube 1 m. in the stopper) and heated to boiling over the steam bath with repeated shaking. The flask is then cooled (in ice-water to hurry the analysis) and the water, as soon as the insoluble acids have solidified, poured through a filter into a graduated flask (500–1,000 c. c.). This process is repeated three or four times and the filtrate made up to 500–1,000 c. c., and 100 c. c. taken for titration with decinormal alkali solution. If any excess of acid has been added it is deducted from the total and the remainder is the soluble acid. It is calculated as butyric acid by multiplying number c. c. $\frac{1}{10}$ alkali by .0088.

The insoluble acids are brought into a tared dish, any in the filter or flask being dissolved in ether, dried at 100° with stirring with absolute alcohol to remove water, and weighed.

In the table will be found the results of the analyses.

Triplicate and duplicate analyses of fatty acids in butters and substitutes.

Soluble acid.					Insoluble acid.				
No.	1.	2.	3.	Mean.	No.	1.	2.	3.	Mean.
2	5.14	5.14	5.10	5.12	2	87.43	88.09	87.91	87.81
4	5.20	5.12	5.12	5.14	4	87.88	87.73	87.91	87.84
6	4.48	4.46	4.63	4.52	6	88.25	87.97	87.82	88.02
1	5.57	5.51	......	5.54	20	94.81	95.13	94.46	94.80
3	5.50	5.60	......	5.55	24	95.33	95.38	95.51	95.40
7	4.78	4.60	......	4.69	1	87.70	88.02	....	87.86
8	5.14	4.90	......	5.02	3	86.31	86.55	....	86.43
9	5.07	5.14	......	5.10	8	88.25	87.92	....	88.08
10	4.81	4.76	......	4.78	9	87.53	87.54	....	87.54
11	5.10	4.91	......	5.00	11	88.67	88.63	....	88.65
12	4.90	5.04	......	4.97	12	88.59	88.34	....	88.46
14	4.49	4.49	......	4.49	14	88.89	88.82	....	88.85
15	4.62	4.60	......	4.61	15	87.98	87.04	....	87.51
16	5.70	5.63	......	5.66	16	87.90	87.52	....	87.70
17	4.56	4.25	......	4.40	17	87.97	87.61	....	87.79
18	4.39	4.91	......	4.60	21	93.22	93.63	....	93.42
19	4.38	4.82	......	4.60	22	93.70	93.60	....	93.65
21	.20	.20	......	.20	23	94.52	95.09	......	94.80
22	.56	.56	......	.56					

RESULTS OF ANALYSES.

As has been said, the analyses which have been made up to the present time have been almost entirely of samples obtained in the local markets or the immediate neighborhood. The object in view has been chiefly the developing of the best methods of work, but the results are of value as showing the composition of butters obtained in the public markets of one of our large cities and of the quality manufactured by the dairy interests of the neighboring portions of Maryland and Virginia. Many of the creamery butters were made in widely-separated States, Iowa, Pennsylvania, and New York being represented in Nos. 1701, 1702, and 1700, while the majority of the dairy butters were sold at first hand by farmers within a radius of twenty miles of Washington. Nos. 1708 and 1710 were from the milk of an extremely well-bred Jersey cow of celebrated record, and No. 1724 was the well-known Darlington print of Philadelphia.

There will therefore be found in the following table a basis for characterizing and marking the qualities of a good butter:

Summary of the

No.	Name.	Made at—	Made by—	Bought at—
1700	Commercial Creamery			Washington, D. C., market.
1701	Iowa Creamery			...do
1702	Pennsylvania Creamery			...do
1703	Print	Somerset, Pa		...do
1704	Dairy	Herndon, Va		...do
1705	...do	Leesburg, Va		...do
1706	Pennsylvania Creamery	Myersville, Pa		...do
1707	Grade Alderney	Spencerville, Montgomery County, Maryland.	W. H. Spencer	...do
1708	Jersey Cow, Value 2d	Baltimore, Md	Watts & Seth	
1709	Commercial Tallow			Z. D. Gilman
1710	Commercial Lard			...do
1711	Commercial Oleomargarine			...do
1712	Jersey Cow, Value 2d	Baltimore, Md	Watts & Seth	
1713	Ordinary Tub	Virginia	E. Sherwood	Stall 481, Center Market.
1714	Alderney Print	Washington, D. C	F. K. Ward	Ward's Dairy
1715	Creamery Tub		—— Wixom	436 Ninth street
1716	Tub Print			906 D street
1717	Oleomargarine			916 La. ave
1718	...do	Chicago, Ill	Bannard, Lyman & Co.	
1719	Grade Dairy	Vienna, Fairfax County, Virginia.	Wm. Hunt	Washington, D. C., market.
1720	Alderney	Chain Bridge, Alexandria, Va.	Samuel Titus	...do
1721	Alderney and Short-Horn stock.	Leesburg, Va. (near)		...do
1722	Alderney	Falls Church, Va	C. Perrigo	...do
1723	Hampton Dairy	Hampton, Baltimore, Md	Charles Ridgely	Baltimore, Md
1724	Darlington	Darling, Pa., Aug. 7	J. & J. Darlington.	Oyster's Washington, D. C., market
1725	W. H. Spencer's daughter.	Spencerville, Md., Aug. 7	W. H. Spencer's daughter.	Washington, D. C., market.
1726	W. H. Spencer's granddaughter.	...do	W. H. Spencer's granddaughter.	...do
1727	Alderney	Chain Bridge, Alexandria, Va., Aug. 7.	Samuel Titus	...do
1728	Grade Alderney	Virginia	A. R. Lefevre	...do
1729	Grade	...do	J. P. Dickey	...do
1730	Alderney	Laurel, Md. (near)	—— Harding	...do
1731	Grade Alderney	Spencerville, Md	C. H. Oursler	...do
1732	Grade	Vienna, Fairfax County, Virginia.	J. W. Lynn	...do
1733	...do	...do	Wm. Hunt	...do
1734	Alderney	Chain Bridge, Alexandria, Va.	Samuel Titus	...do
1735	...do	Fairfax County, Virginia	John Saunders	...do

analyses of butters.

Price.	Color.	Water.	Caseine.	Salt.	Fat.	Melting point.	Solidifying point.	Saturation equivalent.	Soluble acid.	Insoluble acid.	Melting point, insoluble acid.	Solidifying point, insoluble acid.	Saturation equivalent, insoluble acid.
		Perct.	*Perct.*	*Perct.*	*Sp. gr.*	°	°		*Perct.*	*Perct.*	°	°	
$0 30	Light yellow .	12.93	1.118	4.45	.91250	33.	......	244.3	4.50	89.55	39.	37.	254.4
35	Deep yellow..	8.96	.977	2.55	.91153	34.	25.	246.7	4.49	88.85	40.5	37.	253.3
30	Light yellow..	10.87	.708	5.13	.91166	34.7	27.	245.2	4.61	87.36	41.2	37.	252.4
40	V. deep yellow	11.44	.553	2.03	.91235	33.	26.5	245.0	5.54	87.86	40.5	37.5	250.1
35	Deep yellow..	11.68	.703	2.55	.91210	33.8	25.	244.9	5.12	87.81	41.8	37.7	252.3
35	Light yellow..	11.14	.634	1.76	.91191	33.8	27.	244.8	5.55	86.43	40.5	37.	251.5
35	Deep yellow..	11.70	.620	2.31	.91250	33.2	25.7	244.4	5.66	87.80	40.2	37.	252.4
35	....do	14.51	.938	1.23	.91205	34.4	27.	246.1	5.14	87.84	41.0	36.	254.5
......	....do	9.98	.660	1.64	.91102	35.7	30.	239.8	6.79	86.72	43.	40.	255.5
......	White	......	......	......	.89897	47.5	35.	280.0	none	94.80	47.	35.5	264.3
......	....do	......	......	......	.90460	35.5	29.5	284.7	none	95.40	39.7	37.	263.4
......	Deep yellow..	9.32	.087	4.03	.90360	32.5	25.5	283.9	none	94.80	42.	37.5	265.9
......	Light yellow..	12.54	.622	1.64	.91089	36.0	25.7	247.1	4.52	88.02	......	......	259.6
20	....do	8.71	1.230	3.83	.91072	33.0	24.0	243.9	4.40	87.79	40.7	36.5	261.1
35	Deep yellow..	9.52	.556	2.11	.91209	34.2	25.	246.4	4.69	88.16	40.2	36.2	256.3
25	Light yellow..	7.34	.520	3.63	.91202	34.0	25.	244.2	4.60	88.01	40.2	36.2	252.1
30	....do	10.50	.402	1.96	.91022	35.5	25.5	248.9	4.60	88.39	41.5	36.5	257.7
20	....do	5.07	.172	3.31	.90488	30.5	20.	282.5	.20	93.42	42.2	36.5	269.7
......	....do	10.28	.305	2.81	.90510	33.5	28.	280.7	.56	93.65	42.5	36.7	267.7
25	....do	9.30	.552	6.15	.91114	35.2	28.5	249.4	5.02	88.08	41.2	36.5	258.6
25	....do	8.35	.532	3.28	.91123	33.5	28.	246.7	5.10	87.54	41.	36.	256.6
25	....do	13.40	.467	1.96	.91039	34.2	29.	252.	4.78	88.71	41.	36.5	250.9
35	Deep yellow..	10.20	.284	2.90	.91147	33.2	28.5	249.5	5.00	88.65	40.7	36.5	259.4
60	....do	14.06	.507	2.78	.91149	35.	27.2	247.3	4.97	88.46	40.7	36.	253.0
100	V. deep yellow	11.07	.455	1.42	.91049	33.9	24.7	252.8	4.21	89.26	40.2	36.5	263.5
30	Light yellow..	13.51	.581	3.33	.91030	36.	24.5	246.7	4.97	87.25	......	......	......
30	....do	9.13	.677	1.08	.91060	35.5	24.7	248.0	4.44	86.82	41.5	37.2	256.9
30	....do	12.92	.427	3.00	.90862	37.5	28.7	255.1	4.00	88.49	41.7	38.	262.0
30	....do	9.63	.297	2.33	.90961	36.5	25.7	249.4	4.49	89.03	42.	38.2	256.8
25	....do	14.02	.719	3.23	.91033	34.9	26.5	247.7	4.68	88.35	40.7	36.5	255.2
28	....do	10.28	.737	1.52	.91134	35.7	24.7	245.7	5.13	87.74	41.5	35.5	257.6
25	....do	12.53	.754	5.50	.90901	36.7	25.	253.1	4.56	89.22	42.	35.5	264.4
25	....do	11.09	.784	2.41	.91036	36.	24.2	251.0	5.17	88.57	41.2	36	260.6
25	....do	10.90	.789	3.05	.91069	35.	24.	247.7	5.18	88.28	41.2	36.	258.6
25	....do	10.61	......	1.50	.90925	35.7	24.5	258.8	3.90	89.89	40.5	35.	264.3
25	....do	9.64	......	1.31	.91011	34.7	23.	252.8	4.56	88.58	41.	34.5	259.2

CHARACTERISTICS OF A GOOD BUTTER.

Creamery butter is more highly valued than that made in a small way, because the conditions of its manufacture are better understood, the machinery more perfect, and the cream used in better condition. In this way a butter is secured of a pleasant color and agreeable flavor.

In respect to chemical and physical composition a good butter should present the following characteristics, viz.:

(1) The percentage of water should not exceed twelve. In most of the samples examined it was less than this.

(2) The percentage of salt may vary within large limits.

In fact, many persons prefer butter perfectly fresh, while others like a large amount of salt. It is doubtful whether the small percentage of salt added ordinarily to butter acts as a preservative. Its only use seems to be one of taste.

Judging from the table 3 per cent. appears to be the amount of salt in American butter, the variations being from a minimum of 1.23 per cent. to a maximum of 6.15. The percentage of salt, therefore, is not to be much regarded in making an estimate of purity. It would probably have to go above 8 per cent. before it could be regarded as an adulteration.

CURD.

(3) How much curd can a good butter have? This is a difficult question.

If a butter should have no caseine in it at all, it would be a strong presumption in proof of adulteration. If it has too much, its keeping properties are impaired.

One per cent. of curd cannot be regarded as an excessive quantity. The best butter, however, should contain less than this amount. On account of the great difficulty of estimating the percentage of curd, it would not be safe to make it a criterion of purity.

SPECIFIC GRAVITY OF THE BUTTER FAT.

(4) The fat of genuine butter is heavier than that of tallow, lard, or any of the common fats used as adulterants. The specific gravity of butter fat is about 912, water being taken at 1,000. On the other hand, tallow and lard have a relative weight of only 900 or less. This is a slight difference, and yet it is a valuable one when the question of adulteration is raised. But the difference is so small that only the most careful work in determining the specific gravity with strict attention to temperature and manipulation give it any value. Inasmuch as most of the fats which are used as butter surrogates are liquid at 40° C. (104° F.) this temperature of determination has been used in the foregoing analyses.

The numbers given were not obtained by calculation, but by direct comparison with distilled water at the same temperature. While this method is not absolutely correct, owing to slight differences in the rates of expansion of water and oils, it yet gives the comparative differences, and these are of the greatest importance in such analyses. A butter affording a fat whose specific gravity taken as above falls below 910, would have its genuineness subjected to doubt.

SATURATION EQUIVALENT.

(5) The quantity of alkali required to saponify the fat is another means of judging of the purity of a butter.

Butter fat contains an acid (butyric) which has a lower molecular weight than the oleic, margaric, and palmic acids, which form nearly all of the common butter adulterants. By reason of this difference the quantities of alkali necessary for saponification are different for equal weights of butter fats and those of lard, tallow, &c. This difference is strikingly illustrated in the table of analyses, and is the most reliable evidence of the purity or impurity of the sample under consideration. The manipulation of the analysis being an easy one, the determinations of the saturation equivalent is generally the first test in determining the genuineness of the butter. If this number should fall under 250 it would be safe to call the sample genuine butter.

SOLUBLE ACIDS.

(6) Pure butters have a large percentage of acids soluble in water. The percentage of these acids to the total weight of direct butter fat is about five. In the analyses given this percentage does not fall below 4.49, nor rise above 6, except in one case of Jersey butter, made under exceptional conditions. In the butter substitutes these acids rarely go above .5 per cent. Their determination, therefore, is an almost certain one of the purity of the sample.

OPTICAL PROPERTIES.

(7) Pure unmelted butter, when reviewed through a selenite plate by polarized light, presents a uniform tint over the whole field of vision.

On the other hand, butter substitutes give a field of vision of a mottled appearance. This phenomena is so marked that, with a little experience, the observer will be able to tell a genuine from an artificial butter with a fair degree of accuracy. While the examination should never stop with this optical test above, it can be advantageously used as a preliminary step.

MILK ANALYSIS.

Under instructions from this Bureau, Mr. Woodbury Blair placed two cows of his herd, Belle and Kitty, under special control. The object of the experiments was not to determine the total quantity of milk produced nor of the rations consumed, but to see if the character of the milk was influenced by the admixture of ensilage with the food. The cows were first placed on a diet of ensilage, bran, &c., cotton-seed meal. The milk of the cows taken in the morning was subjected to analyses for ten consecutive days.

The food was then changed to chopped hay, bran, and corn-meal, and the analyses made as above. The rations were then changed to those of the first trial, and the analyses continued for two weeks longer. At the time of each change of diet the constituents of the milk were subject to some variations, which passed away after a day or two. In general it may be said that the use of ensilage produced no marked change in the character of the milk. In the case of Belle the percentage of sugar

was slightly decreased and that of fat increased by the ensilage diet. With Kitty the ensilage diet appeared to increase the sugar, but to diminish the fat. A much larger number of determinations, however, must be made before any definite statement concerning the effects of the ensilage diet can be made. Much, indeed, depends on the character of the ensilage food. This is so variable that in all experiments the ensilage employed should be subjected to frequent examination.

Analyses of the ensilage employed will be found in a subsequent part of this report.

Analyses of milk from W. Blair's cows.

COW: BELLE. FEED: ENSILAGE.

Serial number.	Specific gravity.	Cream by volme.	Sugar by polariscope.	Sugar and alcohol extract.	Fat and ether extract.	Total albumen.	Total solids.	Solids not fat.	Ash.	Not determined.
		Pr. ct.								
8	1.0336	12	4.01	3.71	5.28	3.27	14.06	8.78	.608	.89
15	1.0323	12	4.25	4.25	4.81	......	13.90	9.09	......	......
18	1.0332	15	4.40	3.14	5.44	......	14.86	9.42	.661	......
33	1.0316	13	4.11	4.39	4.67	3.85	14.00	9.33	.668	.70
28	1.0308	15	......	3.91	5.56	......	14.94	9.38	.635	......
30	1.0324	11	......	4.19	4.83	4.02	14.54	9.71	.661	......
36	1.0317	13	......	4.24	5.35	3.85	14.63	9.28	.580	......
38	1.0321	17	......	4.16	5.71	2.77	15.38	9.47	......	......
44	1.0318	16	4.22	4.14	5.20	3.82	14.64	9.43	.750	.65
47	1.0293	16	4.12	4.04	5.66	3.75	14.89	9.22	.625	.63
50	1.0311	16	4.25	4.25	5.32	3.50	14.61	9.29	.565	.97
56	1.0318	16	4.35	4.66	5.94	3.08	15.74	9.80	.735	1.62
81	1.0287	16	4.06	4.34	5.88	3.78	15.28	9.40	.760	.80
91	1.0305	13	4.12	3.67	5.28	3.71	14.56	9.28	.545	.90
93	1.0308	16	4.27	4.19	6.04	3.71	15.33	9.29	.700	.61
95	1.0315	14	3.97	3.83	5.12	3.71	14.44	9.32	.735	.90
97	1.0333	16	4.26	4.02	5.06	3.85	13.58	8.52	.770	—.36
99	1.0318	14	4.18	4.20	5.67	3.75	13.36	8.19	.740	—.48
01	1.0334	19	4.28	4.09	5.38	4.03	14.99	9.61	.770	.53
103	1.0322	16	4.33	4.20	5.66	3.85	15.20	9.54	.750	.61
105	1.0327	16	4.09	4.33	4.86	3.78	14.21	9.35	.765	.71
107	1.0329	16	4.04	4.02	5.42	3.85	14.69	9.27	.706	.62
Average	1.0318	15	4.18	4.09	5.37	3.68	14.65	9.27	.689	.64

COW: BELLE. FEED: CHOP.

Serial number.	Specific gravity.	Cream by volme.	Sugar by polariscope.	Sugar and alcohol extract.	Fat and ether extract.	Total albumen.	Total solids.	Solids not fat.	Ash.	Not determined.
59	1.0317	18	4.03	4.68	5.50	3.78	15.13	9.63	.775	1.04
62	1.0319	13	4.39	4.99	5.03	3.50	14.72	9.69	.770	1.03
63	1.0308	14	4.47	4.63	5.27	3.47	14.85	9.58	.780	.86
65	1.0315	14	4.23	4.46	4.80	3.71	14.72	9.92	.775	1.20
67	1.0319	17	4.41	4.35	5.45	3.54	15.17	9.72	.750	1.02
69	1.0311	18	4.21	4.45	5.53	3.64	14.79	9.26	.760	.65
711	1.0313	15	4.21	4.09	5.29	3.54	14.39	9.10	.625	.72
73	1.0305	16	4.21	4.19	5.58	3.54	14.59	9.01	.640	.62
75	1.0307	15	4.27	4.52	5.55	3.75	15.12	9.57	.770	.78
77	1.0300	16	4.27	4.52	5.53	3.64	14.63	9.10	.720	.47
79	1.0306	14	4.30	4.61	4.62	3.57	13.87	9.25	.730	.65
81	1.0304	11	4.26	4.07	4.99	3.71	14.31	9.32	.560	.79
83	1.0297	14	4.10	3.95	5.02	3.61	13.65	8.63	.750	.17
85	1.0311	14	4.27	4.63	3.83	3.61	13.38	9.55	.755	.91
87	1.0323	16	4.53	4.85	5.37	3.75	15.28	9.91	.745	.88
Average	1.0310	15	4.28	4.51	5.16	3.63	14.57	9.42	.727	.73

Analyses of milk from W. Blair's cows—Continued.

COW: KITTY. FEED: ENSILAGE.

Serial number.	Specific gravity.	Cream by volume.	Sugar by polariscope.	Sugar and alcohol extracts.	Fat and ether extract.	Total albumen.	Total solids.	Solids not fat.	Ash.	Not determined.
		Pr. ct.								
9	1.0319	9	4.96	4.09	5.37	2.85	14.38	9.01	.635	.56
14	1.0328	11	5.02	4.77	5.10	3.36	14.44	9.34	.637	.83
17	1.0332	11	4.90	4.23	4.45	3.66	14.11	9.66	.652	.44
23	1.0331	10	4.81	4.31	5.06	3.71	14.65	9.59	.578	.49
27	1.0328	10	......	4.87	4.60	......	14.29	9.69	.612	......
29	1.0322	11	4.55	4.74	5.40	3.64	14.89	9.49	......	......
35	1.0327	14	......	4.56	5.30	3.43	14.71	9.40	.595	......
37	1.0329	10	......	4.53	4.79	3.54	14.32	9.53	......	......
43	1.0327	11	4.74	4.55	4.86	3.61	14.24	9.38	.735	.29
46	1.0309	11	4.58	4.26	5.19	3.36	14.50	9.31	.565	.80
49	1.0317	14	4.73	4.52	6.37	3.33	15.71	9.34	.640	.64
55	1.0232	10	4.58	4.57	5.42	......	14.67	9.25	.710	......
58	1.0327	......	4.66	5.07	5.29	3.71	15.02	9.73	.730	.50
61	1.0324	9	4.70	4.93	4.83	......	14.40	9.57	.665	......
64	1.0300	12	4.39	4.47	5.81	......	15.06	9.25	.705	......
66	1.0316	14	4.59	4.47	5.81	3.54	15.34	9.53	.755	.64
68	1.0309	......	4.67	4.85	6.05	3.43	15.59	9.54	.680	.76
70	1.0289	12	3.98	4.44	4.11	3.54	12.69	8.58	.750	.31
72	1.0302	13	4.57	4.28	6.56	3.43	15.75	9.19	.560	.63
74	1.0310	12	4.59	4.69	5.33	3.57	14.64	9.31	.630	.52
76	1.0313	11	4.65	4.37	5.17	3.54	14.33	9.16	.740	.23
78	1.0315	15	4.83	4.88	5.76	3.54	15.36	9.60	.700	.53
80	1.0313	15	4.59	4.79	5.14	3.22	14.28	9.14	.735	.59
82	1.0324	16	4.64	4.79	4.23	3.47	13.79	9.56	.595	.85
84	1.0316	16	4.61	4.00	4.50	3.68	13.47	9.97	.740	—.06
86	1.0317	12	4.64	4.77	4.74	3.33	14.21	9.47	.715	.78
88	1.0325	13	4.67	4.71	5.19	3.78	14.89	9.70	.730	.52
Average	1.0315	12	4.65	4.57	5.20	3.49	14.58	9.46	.622	.52

COW: KITTY. FEED: CHOP.

Serial number.	Specific gravity.	Cream by volume.	Sugar by polariscope.	Sugar and alcohol extracts.	Fat and ether extract.	Total albumen.	Total solids.	Solids not fat.	Ash.	Not determined.
90	1.0315	12	4.67	4.05	5.05	3.47	14.56	9.51	.710	.66
92	1.0305	16	4.58	3.78	6.08	3.61	15.76	9.66	.685	.81
94	1.0303	12	4.68	3.83	5.91	3.64	15.26	9.35	.675	.35
96	1.03'3	12	4.59	4.59	5.55	3.71	15.02	9.47	.690	.48
98	1.0321	13	4.62	4.36	5.35	3.68	14.84	9.49	.710	.48
100	1.0306	15	4.52	4.09	5.90	3.50	14.90	9.00	.710	.27
102	1.0316	14	4.49	4.12	5.45	3.78	14.84	9.49	.715	.40
104	1.0310	11	4.25	4.45	6.09	3.19	15.59	9.50	.745	1.31
106	1.9315	11	4.33	4.59	5.33	3.40	14.44	9.11	.715	.66
108	1.0309	11	4.21	4.04	5.80	3.68	14.86	9.06	.720	.45
Average	1.0311	13	4.49	4.19	5.65	3.57	15.01	9.36	.707	.68

ADDITIONAL MILK ANALYSES.

In the following tables are given the results of the remaining analyses of milk made by this Bureau. They will be of interest to the farmer and dairyman in showing the variations in the character of the milk taken under varying conditions. The character of the food and other details of the work are shown in the tables.

Milk from F. H. Smith, Hyattsville, Md.

Serial number.	Feed.	Specific gravity.	Cream by volume.	Sugar by polariscope.	Sugar and alcohol extract.	Fat and other extract.	Total albumen.	Total solids.	Solids not fat.	Ash.	Not determined.
			Pr. ct.								
1	Ensilage	....	10	3.36	4.45	5.37	......	14.32	8.95	.624	......
4	......do	1.0287	12	4.10	4.52	5.44	......	14.19	9.75	.615	......
5	......do	1.0297	12	4.47	4.46	5.22	3.25	14.19	8.97	.577	1.02
11	......do	1.0285	15	4.58	4.48	6.27	3.21	15.12	8.85	.701	.45
12	......do	1.0208	24	4.12	4.10	9.95	3.02	18.21	8.26	.724	.39
20	......do	1.0289	13	4.45	4.72	5.32	3.21	14.19	8.78	.712	.49
	Average	1.0273	14	4.18	4.42	6.26	3.17	15.04	8.93	.659	.59
24	Chop	1.0272	13	4.17	4.69	3.95	......	12.58	8.63	.701	......
26	......do	1.0290	9	4.37	4.60	3.01	3.01	12.49	9.48	.577	1.42
32	...... do	1.0279	9	......	4.95	4.66	......	13.29	8.63	.608	......
34	......do	1.0281	12	4.37	4.59	5.30	2.87	13.90	8.60	.652	.70
40	......do	1.0288	17	4.18	4.39	7.10	2.42	16.51	9.41	......	......
42	......do	1.0274	16	3.81	4.26	6.70	3.36	15.43	8.73	.810	.75
48	......do	1.0231	19	3.84	3.84	8.26	3.36	16.88	8.62	.735	1.68
53	......do	1.0233	20	3.72	3.84	8.54	3.54	17.23	8.69	.585	.84
57	......do	1.0261	16	3.72	4.17	7.06	3.40	15.73	8.67	.785	.76
60	......do	1.0253	20	3.82	4.23	8.18	3.61	17.14	8.96	.775	.75
	Average	1.0266	15	4.00	4.36	6.28	3.20	15.12	8.84	.623	.98

Milk from G. L. Higby, Woodley Lane, D. C.

2	Ordinary dairy cattle food	....	5	2.03	3.92	2.37	......	9.46	7.09	.443	......
3	......do	1.0309	7	4.15	4.57	3.29	......	12.06	8.77	.667	......
10	......do	1.0275	8	4.33	4.16	3.56	2.00	11.23	7.67	.492	.84
13	......do	1.0256	5	4.87	4.80	3.19	3.92	11.91	8.72	.576	—.64
16	......do	1.0318	11	......	......	......	......	......	......	......	......
21	......do	1.0311	8	4.87	4.88	3.56	3.05	14.41	10.85	.548	2.38
25	......do	1.0308	8	4.93	4.96	3.77	......	12.82	9.05	.549	......
33	......do	1.0308	7	......	4.81	3.72	2.94	12.41	8.69	.644	......
39	......do	1.0250	4	......	4.02	5.65	3.43	9.36	3.71	......	......
41	......do	1.0290	8	4.62	4.60	3.19	2.63	11.33	8.14	.645	.24
45	......do	1.0294	6	4.54	4.51	3.01	2.84	11.41	8.40	.530	.49
51	......do	1.0310	8	4.61	4.45	3.29	2.94	12.20	8.91	.645	.71
54	......do	1.0307	10	4.67	4.53	3.36	3.05	12.19	8.83	.595	.54
	Average	1.0295	7	4.36	4.52	3.50	2.98	11.73	8.24	.576	.65
	Sample.										
6	Mr. Blair	1.0303	14	5.79	3.92	5.78	3.99	15.25	9.47	.630	—.94
7	....do	1.0295	11	4.32	4.35	5.16	......	14.52	9.36	.587	......
31	Dr. Loring	1.0333	8	......	5.24	4.71	3.08	14.41	9.70	.608	......
52	....do	1.0332	6	5.25	4.92	4.28	3.33	14.03	9.75	.625	.54
19	Mr. Dodge	1.0308	7	3.85	3.30	3.31	3.24	12.01	8.70	.605	.80

PROPERTIES OF A GOOD MILK.

(1) *Specific gravity.*—The specific gravity of a fair average milk is about 1.030; when the cream has been removed this number is larger. It is a very common practice in milk adulterations to remove the cream and then add water until the density of the milk is reduced to its original degree. For this reason the use of the lactometer in determining the purity of a milk from its specific gravity may lead to serious error. It is true also that perfectly genuine may vary greatly in specific gravity. The density of the milk taken at the beginning of milking is always greater than that of the milk taken at the end of the process. This arises from the well-known fact that the first of the milking is always poorer in fat than the last. In fact the last of the milking, the "strippings," is often almost pure cream. Unless, therefore, the conditions

under which the sample of milk is obtained are known, the number expressing its density is not conclusive in respect of its genuineness.

This is a question, however, which has been most thoroughly discussed in connection with official control of the sale of milk, and it would not be profitable to reopen the argument.

(2) *Volume of cream.*—The volume of cream which a given milk will afford depends on many conditions. Among the causes which determine the variation may be mentioned distance and time of transportation, shape of vessel in which the milk is placed, temperature, and time allowed for the cream to rise. On account of these causes of variations, milks taken from the same cow and under conditions as nearly as possible show marked variations in the volume of cream produced. I have also noticed that milks bought at random from the dealers do not show so large a volume of cream as those which are presented for the purpose of analysis. As an illustration of this, reference is made to the table of analyses of milks obtained from Higby. These were purchased from the milk-wagon each morning, and the driver did not know they were for analysis. The mean per cent. of cream by volume is 7.

On the other hand, the milks furnished by Smith were known to be used for analysis. The mean volume per cent. for the two sets is 14½. These significant facts show the importance of having complete control of the feeding and milking the cows in the subsequent studies of the Department in this direction. In fact, I may add that the value of milk analyses in determining a standard of comparison for American milks depends chiefly on such a supervision as I have mentioned.

(3) *Fat.*—The percentage of fat in a milk is not always proportionate to the volume of the cream. Therefore the determination of the fat or ether extract gives a better index of the butter-making value of the milk than is afforded by the volume of the cream alone. Inasmuch as the real market value of a milk depends largely on its content of fat, the numbers given in the preceding tables for the fat per cents will be studied with interest. It appears that the percentage of fat in American milk (107 analyses) is not far from 5.

Solids not fat.—When milk is evaporated to dryness and the water-free residue weighed the percentage of total solids is obtained. If the percentage of fat is subtracted from this number the percentage of "solids not fat" is given. This percentage is nearly a constant quantity, and in average milk is not far from 9.2. When the number falls below 9 it is fair to presume that the milk has been watered or is of an inferior quality.

It would be out of place here to go into further details concerning the analysis of milk and its adulteration. This subject will be presented at a subsequent time in the form of a special report.

REPORT OF THE ASSISTANT CHEMIST.

BUREAU OF CHEMISTRY, DEPARTMENT OF AGRICULTURE,
Washington, D. C., September 11, 1884.

SIR: I have the honor to submit for publication in the Annual Report of the Department for 1884 the following synopsis of the work of the past year which has been carried on under my direction.

Thanking you for the sincere support you have given me in the work,
I am, very respectfully,

CLIFFORD RICHARDSON,
Assistant Chemist.

DR. H. W. WILEY,
Chemist.

INVESTIGATIONS OF AMERICAN CEREALS AND THEIR PRODUCTS.

The investigations of the past year has been confined almost entirely to wheat and its products, previous analyses of corn having been sufficient in number to demonstrate the very universal uniformity of its composition. A number of weighings of varieties of the latter have been made, however, to obtain information as to the size of kernels grown in different portions of the country, and a few determinations of ash and albuminoids.

The wheats which have been analyzed, while including some scattered specimens, which have from time to time come to hand, have been principally from parts of the country which were not well represented in our previous report, or where those which have been selected were deemed by good judges to be not truly characteristic of the State, as in the case of Minnesota. A selection from Professor Blount's crop of 1883 has also been examined, it being the third consecutive year in which Colorado varieties grown under his direction have been analyzed. The roller process of milling having attracted much attention and taken a prominent position in the methods of milling at the present day, a complete series of samples illustrative thereof has been supplied by C. A. Pillsbury & Co., of Minneapolis, and partial series by Warder & Barnett, of Springfield, Ohio, and Herr & Cissel, of Georgetown, D. C., together with numerous flours from different millers in Minnesota and elsewhere, manufactured by gradual reduction.

The question of the susceptibility of flour and other grain products to the humidity of the atmosphere has also been a subject of consideration, and baking experiments with flours from various States and of different grades have been carried on for comparison with similar work done in England a few years ago, in which some of our wheats were included.

WHEAT.

In previous reports the analyses included determinations of water, ash, oil, fiber, and albuminoids. During the past year the determinations of oil and fiber have been omitted, as the slight variations which have been found to occur are of less importance in the consideration of the value of the grain, and as the data already obtained are quite sufficient for this purpose. The determination of the albuminoids in connection with the size and condition of the wheat settle, as far as a chemical and physical examination can succeed, the peculiarities of the samples in hand.

The results are presented in the following tables, arranged in the same manner as in previous reports. There is also a table giving such analyses of wheats from other sources as have not hitherto been collected:

Analyses of American wheats, arranged by States.

Serial number.	Name.	Form.	Color.	Consistency.	Year of growth.	Weight of 100 grains.	Water.	Ash.	Undetermined.	Albuminoids.	Nitrogen.
	PENNSYLVANIA.					*Grams.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
2722	Martin's Amber	Fine	White	Hard	1883		11.30	2.03	73.54	13.13	2.10
	VIRGINIA.										
1851	White Mediterranean	Good	White	Soft	1883	4.255	7.73	2.32	78.92	11.03	1.76
2089	Fultz and Longberry	Fine			1883		9.62	1.93	75.67	12.78	2.04
2112	Osterey	Fair	Yellow	Hard	1883	3.565	9.22	2.50	75.68	12.60	2.02
2113	Red	...do	Red	Medium	1883	3.465	9.33	2.15	77.32	11.20	1.79
	WEST VIRGINIA.										
1846	Early Amber	Fair	Amber	Soft	1883		9.42	2.00	77.73	10.85	1.74
1853	Osterey	...do	Yellow	Medium	1883	3.392	7.68	2.13	79.16	11.03	1.76
	ALABAMA.										
1847	Dallas	Fair	Yellow	Hard	1882	4.447	9.29	1.79	77.72	11.20	1.79
1848	...do	...do	...do	...do	1883	4.277	10.31	1.69	77.67	10.33	1.65
	OHIO.										
2701	Royal Australian	Fair	White	Soft	1883	4.092	10.53	1.80	76.99	10.68	1.71
2702	Treadwell	...do	Amber	Medium	1883	3.407	11.16	1.97	75.14	11.73	1.88
2703	Champion Amber	...do	...do	...do	1883	3.268	12.31	2.03	74.46	11.20	1.79
2704	McPherson	...do	...do	...do	1883	3.503	10.65	2.00	75.62	11.73	1.88
2705	Clawson	...do	Yellow	Soft	1883	3.300	10.54	1.93	73.70	13.83	2.21
2706	Treadwell, bearded	...do	...do	...do	1883	3.590	9.74	2.30	75.18	12.78	2.04
2707	Valley	...do	Amber	Medium	1883	3.250	12.49	1.55	74.06	11.90	1.90
2708	Pool	...do	Red	Hard	1883	3.500	10.60	1.90	75.42	12.08	1.93
2709	Landreth	...do	White	Soft	1883	3.900	11.82	1.73	75.25	11.20	1.79
2710	Theiss	Shriv'l'd	Red	Hard	1883	2.988	10.95	2.00	73.22	13.83	2.21
2711	Michigan Amber	Fair	Light red	...do	1883	5.890	10.42	2.06	75.79	11.73	1.88
2712	Finley	...do	Amber	Medium	1883	3.587	10.00	1.96	74.04	14.00	2.24
2713	Zimmerman	Shriv'l'd	...do	...do	1883	3.328	11.39	2.04	73.44	13.13	2.10
2714	Golden Drop	Fair	...do	...do	1883	3.555	11.86	1.74	74.32	12.08	1.93
2715	Rocky Mountains	...do	...do	...do	1883	3.055	9.56	1.77	75.37	13.30	2.13
2716	Travis	Plump	Light amber	Soft	1883	2.987	10.66	2.20	74.89	12.25	1.99
2717	McGehee's White	Mixed	White	...do	1883	3.225	10.68	1.75	74.97	12.60	2.02
2718	White Velvet	...do	Amber	...do	1883	2.780	10.60	2.06	75.44	11.90	1.90
2719	Russian	...do	...do	Medium	1883	2.644	9.87	2.09	73.34	14.70	2.35
2720	Nigger	Plump	Red	Hard	1883	4.162	10.67	1.81	76.14	11.38	1.82
2721	Wayne's Select	Mixed	Yellow	Soft	1883	2.663	10.73	1.75	74.22	13.30	2.13

Analyses of American wheats, arranged by States—Continued.

Serial number.	Name.	Form.	Color.	Consistency.	Year of growth.	Weight of 100 grains.	Water.	Ash.	Undetermined.	Albuminoids.	Nitrogen.
	OHIO—Continued.										
						Grams.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
2722	Bennett	Fair	Yellow	Soft	1883	2.885	10.69	1.81	74.55	12.95	2.07
2723	Silver Chaff	do	do	do	1883	3.270	10.11	1.87	76.29	11.73	1.88
2724	McGehee's Red	do	Amber	Medium	1883	3.288	9.76	1.87	74.02	14.35	2.30
2725	Lancaster	do	Light red	Hard	1883	3.887	9.90	2.15	72.90	15.05	2.41
2726	Rogers	do	Amber	do	1883	3.108	9.48	1.65	75.39	13.48	2.16
2727	Red Fultz	do	Red	do	1883	3.290	11.32	2.05	73.33	13.30	2.13
2728	Tasmanian	do	do	do	1883	3.581	10.60	2.05	73.70	13.65	2.18
2729	Michigan Bronze	do	do	do	1883	4.093	10.58	1.89	76.85	10.68	1.71
2730	Golden Straw	do	Amber	Medium	1883	3.759	10.30	2.00	74.22	13.48	2.16
2731	Velvet Chaff	do	Red	Hard	1883	3.983	10.16	2.10	72.51	15.23	2.44
2732	German Amber	do	do	do	1883	3.765	9.75	2.02	73.53	14.70	2.35
2733	Democrat	Plump	White	Soft	1883	3.317	10.03	2.14	75.75	12.08	1.93
2734	York White Chaff	Mixed	Yellow	do	1883	3.105	11.45	1.90	74.57	12.08	1.93
2735	Rice	do	Amber	Medium	1883	3.393	11.36	2.09	72.37	14.18	2.27
2736	Mediterranean	Plump	do	Hard	1883	3.940	11.13	2.13	70.64	16.10	2.58
2737	Martin's Amber	Fair	White	do	1883	3.342	11.32	2.03	74.40	12.25	1.96
2738	Fultz	do	Light red	do	1883	3.505	11.37	2.00	73.50	13.13	2.10
2739	Heighes' Prolific	Plump	do	do	1883	3.378	10.05	1.79	74.68	13.48	2.16
2740	Grecian	Mixed	Yellow	Medium	1883	3.312	10.95	1.86	75.99	11.20	1.79
2741	Egyptian	Fair	Amber	do	1883	3.565	11.98	1.76	73.31	12.95	2.07
2742	Sandomirka	do	Light red	Hard	1883	2.905	11.76	1.88	72.53	13.83	2.21
	ILLINOIS.										
1855		Plump			1883		9.05	2.06	76.46	12.43	1.99
	TENNESSEE.										
1850		Fair	Red	Soft	1883		10.92	2.32	74.51	12.25	1.96
	ARKANSAS.										
1849	Mediterranean	Fair	Red	Soft	1883		9.56	2.52	74.97	12.95	2.07
	MINNESOTA.										
2001	C. A. Pillsbury Mill	Plump	Red	Hard	1883	2.720	9.56	1.91	74.35	14.18	2.27
1868	Polk County	Medium	do	do	1883	2.780	8.31	2.05	75.29	14.35	2.30
2107	Minnesota Hard, No. 1	Plump	do	do	1883	2.926	8.05	1.93	76.19	13.83	2.24
2108	do	Fine	do	do	1883	3.577	8.11	1.76	74.90	15.23	2.41
1861	Cass County	Plump	do	do	1883	2.841	8.89	1.89	73.12	16.10	2.58
1862	do	do	do	do	1883	2.771	7.71	1.95	74.24	16.10	2.58

1863	....do	...do	....do	....do	1883	3.312	7.67	2.10	75.70	14.53	2.83
1864	....do	...do	....do	....do	1883	2.802	7.78	1.91	75.18	15.23	2.44
1865	....do	...do	....do	....do	1883	3.868	8.48	1.76	72.48	17.33	2.77
1866	....do	...do	....do	....do	1883	3.389	8.47	1.96	75.57	14.00	2.24
1867	....do	...do	....do	....do	1883	2.921	8.56	2.07	75.02	14.85	2.30
1869	La Moure County	...do	....do	....do	1883	3.700	8.07	1.99	73.06	16.28	2.60
2111	....do	...do	....do	....do	1883	3.074	9.57	1.89	70.51	18.03	2.88
2110	Pembina	...do	....do	....do	1883	3.335	9.92	1.84	75.81	12.48	1.90
	PROVINCES.										
2106	Saskatchiwan	Plump	Red	Hard	1883	3.111	8.85	1.92	73.65	15.58	2.49
2109	Manitoba	...do	....do	....do	1883	3.465	7.84	1.83	77.35	13.48	2.16
	COLORADO.										
2751	White Chili	Plump	Yellow	Soft	....	3.500	8.28	1.99	79.98	9.80	1.57
2752	Colorado Red Chaff	...do	Yellow amber	Medium	....	3.478	9.16	2.01	79.03	9.80	1.57
2123	No. 6 Eldorado	...do	Yellow	Hard	1883	4.223	9.53	1.95	78.72	9.80	1.57
2124	C No. 8, Defiance	...do	....do	Soft	1883	3.774	9.79	1.74	77.79	10.68	1.71
2125	Blount's No. 9	...do	....do	... do	1883	4.503	9.53	1.97	78.00	10.50	1.68
2126	Blount's No. 10	...do	....do	Medium	1883	5.024	8.68	2.26	78.03	11.03	1.76
2127	College No. 10, Oregon Club	...do	....do	Hard	1883	3.714	8.75	2.10	77.77	11.88	1.82
2128	College No. 13, White Mexican	...do	....do	Soft	1883	4.442	8.85	2.20	77.55	11.90	1.90
2129	College No. 14, Improved Fife	...do	Amber	Hard	1883	3.784	9.28	2.04	74.85	13.83	2.21
2130	College No. 15, Russian	...do	Red	....do	1883	3.808	8.15	2.07	77.53	12.25	1.96
2189	Blount's No. 13	...do	....do	... do	1883	3.699	10.27	2.16	76.89	10.68	1.71
2131	Blount's No. 15	...do	....do	V. hard	1883	3.572	8.87	2.03	77.87	11.73	1.88
2182	Blount's No. 16	...do	Amber	Hard	1883	5.036	8.70	2.13	78.14	11.03	1.76
2183	Sonora collection No. 12	...do	Yellow	Soft	1883	3.618	9.12	1.96	76.14	12.78	2.04
2184	Rio Grande collection No. 17	...do	Red	Medium	1883	4.162	8.89	2.03	76.13	12.95	2.07
2185	Blount's No. 17	...do	... do	Hard	1883	4.818	8.90	2.23	74.52	14.35	2.30
2186	Blount's No. 18	...do	Amber	....do	1883	3.351	9.16	2.10	77.71	11.03	1.76
2187	College No. 19, Judkin	...do	....do	Medium	1883	3.761	9.13	1.91	77.41	11.55	1.85
2188	Blount's No. 19	...do	Yellow	Soft	1883	3.442	9.47	1.96	78.59	9.98	1.60
2139	College No. 20, Lost Nation	...do	Amber	Hard	1883	3.739	9.98	1.87	76.65	11.55	1.85
2140	Blount's No. 21	...do	... do	Soft	1883	3.543	9.51	1.89	77.75	10.85	1.74
2141	College No. 21, Touselle	...do	Yellow	Hard	1883	4.247	10.78	2.12	73.85	13.30	2.13
2142	College No. 22, Australian Club	...do	....do	Medium	1883	4.425	8.97	1.97	78.08	11.08	1.76
2143	Blount's No. 23	...do	....do	Soft	1883	3.942	9.09	1.31	78.10	10.50	1.68
2144	Blount's No. 24	...do	....do	....do	1883	3.004	9.58	2.07	78.55	9.80	1.57
2145	Blount's No. 25	...do	....do	Medium	1883	3.873	9.80	2.14	77.71	10.85	1.74
2146	Blount's No. 26	...do	....do	....do	1883	3.987	9.40	2.20	74.02	14.38	2.38
2147	Blount's No. 27	...do	....do	....do	1883	2.645	9.46	1.98	79.63	8.93	1.43
2148	Blount's No. 28	...do	....do	....do	1883	3.827	9.32	2.28	78.42	9.98	1.60
2149	Blount's No. 29	...do	....do	Hard	1883	2.998	9.33	1.91	79.66	9.10	1.46
2150	Blount's No. 30	...do	....do	Medium	1883	2.897	9.70	1.81	79.21	9.28	1.48
2151	Blount's No. 31	...do	....do	....do	1883	3.821	10.40	2.19	78.81	6.10	1.46
2152	Blount's No. 33	...do	Yellow	Hard	1883	2.716	10.15	1.87	79.05	8.93	1.43
3153	Pringle No. 6	...do	....do	....do	1883	4.651	9.30	2.08	74.97	13.65	2.18
2154	Pringle No. 7	...do	....do	Soft	1883	3.968	9.15	2.05	76.72	12.08	1.93

Analyses of American wheats, arranged by states—Continued.

Serial number.	Name.	Form.	Color.	Consistency.	Year of growth.	Weight of 100 grains.	Water.	Ash.	Undetermined.	Albuminoids.	Nitrogen.
	COLORADO—Continued.					*Grams.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
2155	Blount's No. 34	Plump	Amber	V. hard, glassy	1883	5.179	8.82	2.43	76.15	12.60	2.02
2156	Blount's No. 35	do	Yellow	Soft	1883	3.055	9.37	2.27	77.86	10.50	1.68
2157	Blount's No. 36	do	Amber	Hard	1883	3.224	9.08	2.00	78.24	10.68	1.71
2158	Blount's No. 37	do	Yellow	Medium	1883	3.559	10.72	2.44	74.94	11.90	1.90
2159	Black Bearded Centennial, collection No. 40	do	do	Hard	1883	5.578	8.60	2.10	77.45	11.85	1.85
2160	College No. 41, Hedge Row, White Chaff	do	do	Soft	1883	2.838	9.16	2.02	77.09	11.73	1.88
2161	College No. 69, Hedge Row, Red Chaff	do	do	Medium	1883	4.008	9.18	2.19	75.68	12.95	2.07
2162	College No. 71, Fountain	do	do	Soft	1883	4.191	8.27	2.14	77.69	11.90	1.90
2163	College No. 74, White Chaff	do	Red	Hard	1883	3.252	7.95	2.05	77.92	12.08	1.93
2164	College No. 76, Perfection	do	Yellow	do	1883	5.032	10.29	2.08	74.68	12.95	2.07
2165	College No. 79, Triticum	do	do	do	1883	4.861	8.98	2.02	75.00	14.00	2.24
2166	College No. 81, Russian Duram	do	do	Medium	1883	4.761	8.70	2.10	74.85	14.35	2.30
2167	College No. 88, Mukin's	do	Red	do	1883	4.414	10.15	2.05	74.32	13.48	2.16
2168	College No. 77, German Fife	do	Amber	Soft	1883	4.546	10.05	2.28	75.07	12.60	2.02
2169	College No. 110, product of 1883, Prossoe, three years old.	do	Yellow	do	1883	4.275	8.85	2.38	75.47	13.30	2.13
2170	College No. 110, product of 1882, Prossoe, three years old.	do	do	do	1882	4.654	9.62	2.52	75.78	12.08	1.93
2171	College No. 149, product of 1882, winter	do	Amber	Medium	1882	3.438	8.92	2.31	75.99	12.78	2.04
2172	College No. 149, product of 1883, winter, two years old.	do	do	Soft	1883	3.985	9.68	2.14	75.93	12.25	1.96
2174	College No. 173, White Mediterranean, product to spring, 1883.	do	Yellow	do	1883	4.182	9.69	2.19	76.92	11.20	1.79
2176	College No. 174, Red Mediterranean, product to spring, 1883.	do	Amber	V. hard	1883	3.650	9.50	2.10	74.75	13.65	2.18
2178	College No. 175, French Imperial, winter to spring, 1883.	do	do	Medium	1883	4.504	9.55	1.95	75.55	12.95	2.07
2180	College No. 179, Rust Proof, product to spring, 1883.	do	do	Soft	1883	4.957	10.25	2.10	75.22	12.43	1.99
2182	College No. 182, Purple Straw, product winter to spring.	do	do	do	1883	3.231	11.11	2.04	74.25	12.60	2.02
2184	College No. 183, Golden Premium, product winter to spring.	do	Yellow	Medium	1883	3.818	9.44	2.17	77.01	11.38	1.82
2186	College No. 184, Hick's Prolific, product	do	Amber	Soft	1883	2.879	9.21	2.04	78.42	10.33	1.65
2188	College No. 192, Geiger product	do	Yellow	Medium	1883	4.964	9.92	2.20	73.35	14.53	2.32
	UTAH.										
2757	Red Taos	Fair	do	Soft	1875	4.094	9.27	1.93	78.30	10.50	1.68
2758	Leran	do	do	do	1875	3.703	9.07	2.53	78.60	9.80	1.57
2756	Taos	Fair	Yellow	Soft	1882	3.188	9.50	2.10	76.67	11.73	1.88
2760	German	do	do		1875	3.956	9.10	1.77	79.85	9.28	1.47

2743	Propo	Good	...do	Soft	1875	3.616	11.37	1.87	74.68	12.08	1.93
2744	Sonora	...do	...do	...do	1875	3.320	11.40	2.03	76.43	10.15	1.62
2745	Nonpareil	...do	...do	...do	1875	5.184	11.82	1.79	75.19	11.20	1.79
2746	Pride of Butte	...do	...do	...do	1875	3.445	11.18	1.90	76.94	9.98	1.60
2747	Nonpareil	...do	...do	...do	1875	3.905	10.82	1.93	74.47	12.78	2.04
2748	White Chili	...do	...do	...do	1875	4.103	10.47	1.95	75.68	11.90	1.90
2749	White Australian	...do	...do	...do	1875	5.042	10.38	2.02	78.50	9.10	1.46
2750	Jones	...do	...do	...do	1875	3.611	10.16	1.68	78.71	9.45	1.51
2753	Fultz	...do	Red	Hard	1875	3.095	10.20	1.49	76.06	12.25	1.96
2754	White Colorado	...do	Yellow	Soft	1875	3.543	9.53	1.97	78.00	10.50	1.68
	WASHINGTON TERRITORY.										
1854	Walla Walla	Fine	White	...do	1863	2.584	10.13	1.95	80.22	7.79	1.23
2759	Tappahanock	...do	Yellow	Glossy	1871	4.726	9.65	2.02	79.58	8.75	1.40

Analyses of wheats from other sources than the Department of Agriculture.

Name.	Locality.	Year.	Spring or winter.	Water.	Ash.	Fat.	Carbhydrates.	Fiber.	Albuminoids.	Nitrogen.	Analyst.
				Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
Amber-bearded	Maine	......	Spring.	13.35	1.79	2.00	69.06	1.99	11.81	1.89	U. S. Census.
White Winter	New York	......	Winter.	13.07	1.63	1.65	71.23	1.79	10.63	1.70	Do.
Red Winter	...do	......	...do	13.30	1.70	1.59	68.08	1.73	13.60	2.18	Do.
From limestone land	New Jersey	......	...do	13.30	2.09	1.70	69.62	1.90	11.39	1.82	Do.
From gray rock, gravel soil	...do	......	...do	13.67	1.82	1.74	68.34	1.93	12.50	2.00	Do.
No. 1 White Winter	Michigan	......	...do	12.89	1.85	1.56	70.74	1.90	11.06	1.77	Do.
Fultz	Wisconsin	......	...do	12.34	1.89	1.62	71.30	1.76	11.09	1.77	Do.
Red Mammoth	...do	......	Spring.	12.13	2.30	2.07	66.07	2.30	15.13	2.42	Do.
Spring wheat	Minnesota	......	...do	11.13	1.95	....	*72.92	....	14.00	2.24	Kedzie.
Do	Dakota	......	...do	12.60	1.98	1.82	68.09	2.01	13.50	2.16	U. S. Census.
Scotch Fife	...do	......	...do	12.90	1.77	1.82	68.33	1.93	13.25	2.12	Do.
Macaroni	California	1879	Winter	10.70	1.97	1.46	70.21	1.90	13.76	2.20	Do.
Do	...do	1879	...do	10.93	1.45	1.63	71.40	1.75	12.84	2.05	Do.
White Club	...do	1879	...do	11.23	1.93	1.67	74.78	2.14	8.25	1.32	Do.
No. 1, San Francisco Produce Exchange	...do	1879	...do	11.03	1.78	1.77	73.58	2.15	9.69	1.55	Do.

* Fiber, carbhydrates, and fat.

AVERAGES.

The analyses in the preceding tables, when combined with those previously published, modify to a certain immaterial degree the average composition of the wheat of the whole country. The few scattered analyses from the Eastern States change the averages for those States very slightly, the greater number of specimens coming from Ohio, Minnesota, Dakota, and California, localities which were not represented before, or at most indifferently well; and from Colorado, where wheats from the same farm have been examined for three consecutive years:

Average composition of American wheats.

Locality.	Number of analyses.	Number of weights.	Weight of 100 grains.	Water.	Ash.	Undetermined.*	Albuminoids.	Nitrogen.	Weight of 100 grains.		Albuminoids.	
									Highest.	Lowest.	Highest.	Lowest.
			Grams.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Grams.*	*Grams.*	*Per cent.*	*Per cent.*
United States and British America	407	377	3.644	10.16	1.92	75.77	12.15	1.94	5.924	1.830	18.03	7.70
Atlantic and Gulf States	117	105	3.489	10.34	1.77	76.54	11.35	1.81	5.079	1.830	15.58	9.43
Middle States	91	89	3.537	10.61	1.85	75.04	12.50	2.00	5.800	2.138	16.63	10.15
Western States	177	166	3.763	9.83	2.06	75.37	12.74	2.04	5.924	2.561	18.03	8.93
Pacific States	20	15	4.091	10.25	1.87	78.15	9.73	1.56	5.745	2.584	12.78	7.70
Canada	6	....	3.325	9.74	1.56	77.83	10.87	1.74	3.686	2.964	14.70	9.45
Pennsylvania	33	26	3.373	10.73	1.70	76.13	11.44	1.83	4.658	2.035	15.58	9.45
Maryland	9	....	3.597	10.52	1.75	76.08	11.65	1.86	5.079	3.075	14.58	9.80
Virginia	15	14	3.433	9.98	1.84	76.08	12.10	1.93	4.283	1.830	14.00	10.15
West Virginia	2	1	3.392	8.55	2.07	78.44	10.94	1.75	....	....	11.03	10.85
North Carolina	22	....	3.776	10.03	1.59	77.95	10.43	1.67	4.628	2.780	12.43	8.93
Georgia	7	....	3.579	10.00	1.96	76.26	11.78	1.89	4.627	2.834	14.00	9.45
Alabama	19	19	3.424	10.82	1.96	75.93	11.29	1.80	4.647	2.011	13.65	9.80
Ohio	44	44	3.476	10.68	1.94	74.55	12.83	2.05	5.800	2.663	16.10	10.68
Tennessee	15	14	3.150	10.24	1.92	75.34	12.50	2.00	3.990	2.138	16.63	10.15
Kentucky	8	....	3.454	10.83	1.75	74.27	13.15	2.10	3.666	3.146	14.53	11.90
Michigan	22	....	3.969	10.71	1.64	75.98	11.67	1.87	4.902	3.402	15.23	10.50
Missouri	12	....	3.502	9.80	1.92	76.72	11.56	1.86	3.867	3.098	14.00	10.50
Arkansas	1	....	....	9.56	2.52	74.97	12.95	2.07	....	....	....	....
Minnesota	13	13	3.245	9.96	1.77	75.08	13.19	2.11	3.867	2.720	17.15	10.85
Dakota	12	12	3.149	8.84	1.96	74.25	14.95	2.40	3.700	2.771	18.03	12.43
Manitoba	2	2	3.288	8.35	1.63	75.40	14.53	2.32	....	....	....	....
Kansas	10	....	3.204	11.80	1.64	75.41	11.15	1.78	3.424	2.881	12.25	10.50
Texas	19	....	2.847	10.03	1.81	75.02	13.14	2.10	3.937	2.561	15.23	10.68
Colorado	106	98	4.214	9.73	2.21	75.83	12.73	2.03	5.924	2.716	15.94	8.93
Utah	2	2	3.893	9.17	2.23	78.45	10.15	1.62	4.084	3.703	10.50	9.80
New Mexico	2	2	3.572	9.30	1.98	78.22	10.50	1.68	3.956	3.188	11.73	9.28
California	10	10	3.892	10.73	1.86	76.47	10.94	1.75	5.184	3.095	12.78	9.10
Oregon	8	....	5.044	9.74	1.84	79.82	8.60	1.37	5.745	4.258	9.47	8.05
Washington Territory	2	2	3.655	9.89	1.98	79.90	8.23	1.32	4.726	2.584	8.75	7.70

* Fiber, carbhydrates, and fat.

PECULIARITIES IN DIFFERENT LOCALITIES.

OHIO.

The wheats from this State were grown by William B. Alwood, superintendent of field experiments at the farm of the Ohio State Experiment Station. In our original bulletin they were incorrectly stated to have been grown on the University Farm by W. Brotherton.

The crop of 1883 averaged, it is said, about 30 bushels per acre. It was not, however, entirely plump, "owing to a wet spring succeeded by dry weather before ripening," and the weight per bushel was therefore light, about 57 pounds. The fact that the grain was shriveled was due to a lack of ability to fill the floury portion with its full quantity of starch, and the relative percentage of nitrogen is therefore higher than would be found in a well-developed grain.

This inability to form the usual proportion of starch in the grain, or the reverse, an enhanced starch formation, will be seen to be a powerful factor in altering the composition of the wheat grain. The specimens which have been just mentioned from Ohio, and others from Dakota, Colorado, and Oregon, illustrate the dependence of the relative percentage of nitrogen in the grain upon the amount of starch which it has been able to accumulate.

MINNESOTA.

The specimens previously analyzed from this State were from the exhibits of the Saint Paul, Minneapolis and Manitoba Railroad in the Department Museum, but as they were not considered representative wheats by prominent millers, and the results were unsatisfactory to them, they were invited to send samples of their own selection from the crop of 1883. The analyses given in this bulletin will, therefore, show the composition of the best spring wheat of Minnesota, but it can hardly be said to represent the average of the State, as the samples were all of No. 1 hard wheat.

The average of the analyses previously published, of the four made this year, and of all taken together, are given below:

Analyses and constituents.	Railroad exhibits, &c.	No. 1 hard wheat, 1883.	All.
Number of analyses	9.	4.	13.
Weight of 100 grains ... grams	3.354	3.001	3.168
Water ... per cent	10.60	8.64	9.96
Ash ... do	1.71	1.91	1.77
Undetermined ... do	75.03	75.05	75.09
Albuminoids ... do	12.66	14.40	13.18
Total	100.00	100.00	100.00
Nitrogen ... do	2.03	2.31	2.11

The average of all probably fairly represents the production of the State, while "No. 1 hard spring wheat" is richer in albuminoids, but small in size, both of which characteristics are due to a lack of starch, owing to the short period of growth and rapid maturity and consequent inability to accumulate that constituent.

DAKOTA.

Through the kindness of General M. V. Z. Woodhull, specimens of the crop of spring wheat of 1883 from some of the leading farms of the

Territory have been sent to this division. As will be seen, they are all extremely rich in albuminoids with the exception of that grown in Pembina. One specimen contains 18.03 per cent. of albuminoids, and the ten together average over 15 per cent.

Average composition of Dakota spring wheat, crop of 1883.

Weight of 100 grains .... grams..	3.151
Water .... per cent..	8.51
Ash .... do....	1.94
Undetermined .... do....	74.11
Albuminoids .... do....	15.44
Total	100.00
Nitrogen .... do....	2.47

The wheat containing 18.03 per cent. of albuminoids is the richest which has yet been analyzed in the United States. It was grown in La Moure County by Sykes & Hughes, and is, of course, a spring variety. It would be interesting to observe the composition of a winter wheat grown on that soil.

Of winter varieties only one specimen has been obtained from the Territory. This, in comparison with a spring wheat from the same source, shows that the peculiarities are without doubt due, as has been already mentioned in the case of Ohio and Minnesota, to a difference in the amount of starch stored in the grain.

The size or weight per hundred grains of the two specimens was—

	Grams.
Winter	3.513
Spring	2.755

and the percentages of albuminoids—

Winter	10.68
Spring	14.35

the latter being in inverse proportion to the former, so that if the winter wheat were supposed to be diminished in size at the expense of its starch the relative percentage of nitrogen would rise to a point near that usually found in spring wheats. The spring wheats may, therefore, be regarded as richer in nitrogen, owing, at least to a great extent, to their inability to fill out the grain with starch to a size corresponding with winter grain.

COLORADO.

In a previous report the analyses were published of a large number of wheats from Colorado, grown during the years 1881 and 1882, by Prof. A. E. Blount, of the Agricultural College at Fort Collins. The average composition for each year was as follows:

Average composition of Colorado wheat crops of 1881 *and* 1882.

Analyses and constituents.	1881.	1882.
Number of varieties analyzed	33	12
Weight of 100 grains .... grams..	4.865	4.283
Water .... per cent..	9.86	8.80
Ash .... do....	2.28	1.99
Oil .... do....	2.41	2.38
Carbhydrates .... do....	70.48	72.08
Crude fiber .... do....	1.57	1.76
Albuminoids .... do....	13.40	13.04
	100.00	100.00
Nitrogen .... do....	2.14	2.09

Or for the two seasons:

Average composition of Colorado wheats for the two seasons, 1881 and 1882.

Number of varieties analyzed	45
Weight of 100 grains ... grams	4.682
Water ... per cent	9.57
Ash ... do	2.21
Oil ... do	2.38
Carbhydrates ... do	70.91
Crude fiber ... do	1.62
Albuminoids ... do	13.31
	100.00
Nitrogen ... do	2.13

Specimens of the crop of 1883 have been examined, and the average for that year obtained.

Average composition of Colorado wheat, crop of 1883.

Number of varieties analyzed	57
Weight of 100 grains ... grams	3.941
Water ... per cent	9.38
Ash ... do	2.09
Undetermined ... do	76.79
Albuminoids ... do	11.74
	100.00
Nitrogen ... do	1.88

It is plain that there has been a very marked falling off in albuminoids. Twenty-eight of the fifty-seven varieties examined this year were also among the specimens of 1881. The averages for the two years of the same varieties show in the same way changes such as were seen in the average of all.

Average composition of twenty-seven Colorado wheats in 1881 and in 1883.

Constituents.	1881.	1883.
Weight of 100 grains ... grams	4.947	4.197
Water ... per cent	9.83	9.15
Ash ... do	2.23	2.00
Undetermined ... do	74.52	76.66
Albuminoids ... do	13.42	12.19
	100.00	100.00
Nitrogen ... do	2.15	1.95

There has been a falling off in ash and albuminoids, and in the weight of 100 grains, and the uniformity of the change in these respects is shown by a comparison of each analysis in this regard.

Comparison of the crops of 1881 *and* 1883.

Serial number.	Weight of 100 grains.		Water.		Ash.		Albuminoids.		Nitrogen.	
	1881.	1883.	1881.	1883.	1881.	1883.	1881.	1883.	1881.	1883.
	Grams	*Grams.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
728	4.702		10.55		2.24		11.75		1.88	
2125		4.223		9.53		1.95		9.80		1.57
719			9.72		2.28		13.75		2.20	
2126		5.024		8.68		2.26		11.03		1.76
738	4.434		9.59		1.91		12.25		1.96	
2127		3.714		8.75		2.10		11.38		1.82
729			9.91		2.60		13.81		2.21	
2128		4.442		8.35		2.20		11.90		1.90
734	4.131		9.55		1.99		14.49		2.31	
2130		3.808		8.15		2.07		12.25		1.96
720			10.07		1.93		12.25		1.96	
2131		3.572		8.87		2.03		11.73		1.88
721	4.824		9.53		2.04		11.75		1.88	
2132		5.036		8.70		2.13		11.03		1.76
739	4.739		10.17		2.02		14.18		2.27	
2133		3.618		9.12		1.96		12.78		2.04
735	5.906		9.51		2.08		14.69		2.35	
2134		4.162		8.89		2.03		12.95		2.07
722	5.137		9.93		2.07		13.62		2.18	
2135		4.818		8.90		2.23		14.35		2.30
723			9.74		2.19		12.94		2.07	
2136		3.351		9.16		2.10		11.03		1.76
730			9.75		2.57		12.25		1.96	
2137		3.761		9.73		1.91		11.55		1.87
724			10.55		2.54		12.44		1.99	
2138		3.442		9.47		1.96		9.98		1.60
741	3.851		10.24		2.17		12.93		2.07	
2139		3.739		9.93		1.87		11.55		1.85
736	5.214		10.23		2.10		13.50		2.16	
2141		4.247		10.73		2.12		13.30		2.13
731	5.506		9.78		1.85		11.19		1.79	
2143		4.425		8.97		1.97		11.03		1.76
742	5.145		9.89		2.13		13.13		2.10	
2153		4.651		9.30		2.08		13.65		2.18
743	4.636		9.89		2.23		15.25		2.44	
2154		3.968		9.15		2.05		12.08		1.93
737			9.66		2.35		12.06		1.93	
2159		5.578		8.60		2.10		11.85		1.85
745	4.072		9.07		2.08		13.62		2.18	
2160		2.838		9.16		2.02		11.73		1.88
746	4.499		9.17		2.59		12.94		2.07	
2161		4.208		9.18		2.19		12.95		2.07
732	5.100		10.58		2.70		13.62		2.18	
2162		4.191		8.27		2.14		11.90		1.90
747	4.214		9.57		2.03		14.04		2.25	
2163		3.252		7.95		2.05		12.08		1.93
733	5.536		9.93		1.99		14.18		2.27	
2164		5.032		10.29		2.08		12.95		2.07
748	5.754		10.02		2.67		13.62		2.18	
2165		4.861		8.98		2.02		14.00		2.24
749	5.924		9.91		2.32		15.25		2.44	
2166		4.761		8.70		2.10		14.35		2.30
751	5.193		9.38		2.53		15.15		2.43	
2167		4.414		10.15		2.05		13.48		2.16
737	5.368		10.42		2.31		15.06		2.41	
2168		4.546		10.05		2.28		12.60		2.02

There was a loss of albuminoids in every variety, with four exceptions, and a decrease in weight in all but one. This change, which at first seemed rather surprising, is explained by Professor Blount in the following letter:

COLORADO AGRICULTURAL COLLEGE,
Fort Collins, Colo., June 17, 1884.

MY DEAR SIR: Your letter of the 11th, inclosing analyses of wheats, received. I am not at all surprised at the falling off in the albuminoids and other deleterious changes. I think I can give a satisfactory reason for the deterioration.

First. In June of last year, while these wheats were in the formation stage, we had a heavy and destructive hail-storm, which almost entirely destroyed my whole crop. So badly was it beaten down that it was a month before the crop was where it was before, and not half of it then was making anything like good grain. I find when

the wheat plant is in any way injured the grain especially suffers most. The foliage, if anything, rather flourishes, or, in other words, grows more vigorously and rank. The sap is more abundant, and the grain producing elements much less.

Second. Last year up to August we had much more rain than ever before. Frequent showers, followed by hot suns and damp, sultry air, made many of my wheats rust. Those injured and put back by hail suffered most from rust.

I am satisfied these are the causes of deterioration noticed in the analyses. The difference in the two seasons was as great as that between ours generally and that of Iowa. I think this year will bring out my hybrids with a better showing.

Very truly, yours,

A. E. BLOUNT.

CLIFFORD RICHARDSON, Esq.,
Assistant Chemist.

Professor Blount's conclusions are interesting and undoubtedly correct, and show how sensitive wheat is to causes affecting its development.

Arrested development may apparently produce two results, according to the period in the growth of the plant at which it occurs. In the Colorado specimens, as Professor Blount remarks, the supply of nitrogen was probably cut off by the injury done by storms. In the cases of the Ohio wheats, which owed their small size and shriveled appearance to wet weather just before harvesting, the check to development came after the nitrogenous portion of the seed had been stored up and prevented the accumulation of the starch which was necessary to make a plump grain.

Professor Blount proposes to continue his experiments, and it will be very interesting to observe the quality and composition of succeeding crops.

In 1882 the product of several seed wheats sent to Colorado in 1881 was found to be much richer in albuminoids than the original seed, and in our previous bulletin attention was called to this fact. Of the last year's crop eight varieties were from seed sent to Professor Blount from Washington.

A comparison of the analyses will show the changes during the past unfavorable season:

Comparison of Department seed and Colorado crops, 1882-'83.

Serial number.	Weight of 100 grains.		Water.		Ash.		Albuminoids.		Nitrogen.	
	Seed.	Crops.	Seed.	Crops.	Seed.	Crops.	Seed.	Crops.	Seed.	Crops.
	Grams.	*Grams.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
2173	4.152	....	9.84	....	1.78	....	9.98	....	1.60	....
2174	....	4.182	....	9.69	....	2.19	....	11.20	....	1.79
2175	3.650	....	9.40	....	1.94	....	11.73	....	1.88	....
2176	....	3.650	....	9.50	....	2.10	....	13.65	....	2.18
2177	2.820	....	9.74	....	1.94	....	12.60	....	2.02	....
2178	....	4.594	....	9.55	....	1.95	....	12.95	....	2.07
2179	4.336	....	9.90	....	1.86	....	10.83	....	1.65	....
2180	....	4.957	....	10.25	....	2.10	....	12.43	....	1.99
2181	2.612	....	11.35	....	1.75	....	12.60	....	2.02	....
2182	....	3.231	....	11.11	....	2.04	....	12.60	....	2.02
2183	4.084	....	10.50	....	1.95	....	9.80	....	1.57	....
2184	....	3.818	....	9.44	....	2.17	....	11.38	....	1.82
2185	3.062	....	10.38	....	1.89	....	10.15	....	1.62	....
2186	....	2.879	....	9.21	....	2.04	....	10.33	....	1.65
2187	3.138	....	9.48	....	2.56	....	16.45	....	2.68	....
2188	....	4.064	....	9.92	....	2.20	....	14.53	....	2.32
Average	3.482	3.922	10.07	9.83	1.85	2.10	11.71	12.38	1.88	1.98
Gain	....	6	....	3	....	7	....	7	....	7
Loss	....	2	....	5	....	1	....	1	....	1

The averages show that the crop, notwithstanding unfavorable conditions, has improved in ash and albuminoids and size of the grain, and that the conclusions of previous analyses are verified. The last variety, No. 2187–8, was the only one to lose in percentage of albuminoids, and this was plainly because it contained in the seed a higher amount than could be supported by Colorado conditions in the crop. This same wheat, the Geiger, a spring variety from Asia, it will be noticed contains a large amount of ash in connection with its high percentage of albuminoids, and loses the one with the decrease of the other. Attention has already been drawn to the intimate relation between ash and albuminoids in the whole grain in the previous report, and the reason of this will appear in later analyses, where it is shown that the bran and germ, both storehouses of nitrogen, contain large amounts of ash.

That Colorado is a place where a rich and fine wheat can be raised is evident from the work of the past three years; but it is also plain that all the aid which human agency can control must be given to this end. Two samples of wheat grown in another part of the State, Fremont County, which have been in the Department museum for some time, are not rich in albuminoids, containing each only 9.80 per cent. This variation shows that great care is always necessary to keep the grain at a high standard and that in the case of the wheats from Fremont County something was lacking.

THE PACIFIC COAST.

The conclusion was drawn last year that Oregon produced a wheat extremely poor in albuminoids, although the appearance of the grain was fair and large.

Surprise having been expressed at this statement, it was suggested that an analysis should be made of a selected sample of Oregon wheat of the crop of 1883. For this pursose a specimen was chosen which the Northern Pacific Railroad presented to its guests at a dinner in Walla Walla, during the excursion given by the road in the autumn of 1883. The result (serial No. 1854) was a complete confirmation of previous analyses. The percentage of albuminoids found was 7.70, and this determination having been confirmed by duplication, the wheat was proved to be the lowest in albuminoids of any that have been examined in this country. Its appearance was fine, but the size of the grain smaller than one usually expects in Oregon wheats.

Attempts to obtain samples, typical of the production of the remainder of the coast, have failed, but a consideration of the great range of climate found there, together with a few analyses of samples found in the museum of the Department, lead us to the conclusion that the wheats of California, at any rate as a whole, would not be found to be as starchy as those from Oregon, except where the climate corresponds.

MAIZE.

Before considering the investigations of wheat products, a synopsis of our work upon maize (corn) may well follow.

The average composition of corn from the various States, derived from the analyses published in a previous bulletin, differed very slightly in their percentages of albuminoids. The observations upon this cereal during the past year have been confined, therefore, to determinations of nitrogen and ash in a number of samples from localities from which none had been previously received, and to taking the weights of one hundred kernels of specimens from all parts of the country.

Analyses of American corn by States.

Variety.	Serial number	Ash.	Albuminoids.	Nitrogen.
		Per cent.	*Per cent.*	*Per cent.*
New York:				
Yellow Flint	2393	1.41	9.80	1.57
Do	2394	1.54	12.43	1.99
Do	2395	1.21	9.28	1.48
Do	2396	1.45	9.10	1.46
Do	2397	1.24	9.45	1.51
Do	2399	1.50	10.85	1.74
Do	2400	1.51	10.68	1.71
Do	2402	1.50	10.85	1.74
Do	2403	1.47	12.43	1.99
Illinois:				
Red Dent	2330	1.27	8.75	1.40
White Dent	2331	1.72	12.08	1.93
Do	2932	1.50	10.68	1.71
Yellow Dent	2333	1.37	10.50	1.68
Do	2336	1.52	11.38	1.82
White	2337	1.15	8.40	1.34
Red Dent	2341	1.40	10.33	1.65
White Dent	2343	1.36	8.05	1.29
Yellow Dent	2344	2.60	10.33	1.65
Do	2347	1.32	9.28	1.48
Do	2348	1.59	11.38	1.82
Do	2349	1.35	11.20	1.79
Do	2351	1.17	8.40	1.34
Do	2352	1.22	9.80	1.57
White Dent	2353	1.50	10.33	1.65
Yellow Dent	2356	1.85	11.03	1.76
White Dent	2362	1.58	10.33	1.65
Yellow Dent	2365	1.48	10.15	1.62
Red Dent	2366	1.43	7.88	1.26
White Dent	2368	1.30	10.85	1.74
Minnesota:				
Yellow Dent	1989	1.84	10.85	1.74
Do	1990	1.85	12.43	1.99
Do	1991	1.63	11.20	1.79
White Dent	1992	1.39	9.10	1.46
Yellow Flint	1993	1.74	11.03	1.76
Yellow Dent	1994	1.66	9.80	1.57
White Dent	1995	1.51	9.45	1.51
Yellow Dent	1996	1.73	8.75	1.40
Yellow Flint	1997	1.61	9.80	1.57
Yellow Dent	1998	1.65	9.80	1.57
Do	1999	1.66	10.85	1.74
Do	2202	2.02	8.40	1.34
Do	2203	1.57	9.80	1.57
Red Flint	2204	1.49	9.10	1.46
Mixed Dent	2211	1.78	10.50	1.68
White Dent	2217	1.73	10.33	1.65
Dakota:				
White Dent	2307	1.48	10.33	1.65
Red Dent	2308	1.83	11.38	1.82
Yellow Dent	2309	1.88	11.38	1.82
White Dent	2310	1.55	11.03	1.76
Yellow Dent	2311	1.71	10.68	1.71
Do	2312	1.36	9.63	1.54
Do	2313	1.39	11.20	1.79
Mixed Flint	2314	1.35	10.85	1.74
Yellow Dent	2315	1.96	12.25	1.96
Do	2318	1.71	11.03	1.76
White Dent	2320	1.47	10.33	1.65
Yellow Dent	2321	1.47	9.28	1.48
Red Dent	2322	1.03	11.03	1.76
Do	2325	1.84	10.33	1.65
Do	2328	1.51	10.50	1.68
Nebraska:				
Yellow Dent	2371	1.59	10.15	1.62
Do	2373	1.60	10.33	1.65
Do	2374	1.48	9.80	1.57
Do	2375	1.43	10.50	1.68
Mixed Dent	2376	2.01	9.10	1.46
Yellow Dent	2378	1.37	9.45	1.51
Do	2379	1.50	11.90	1.90
Do	2380	1.64	11.55	1.85
Do	2381	1.63	11.78	1.88
Do	2382	1.43	9.63	1.54
Mixed Dent	2385	1.45	9.63	1.54
Yellow Dent	2386	1.40	12.25	1.96
Do	2388	1.51	10.15	1.62

Analyses of American corn by States—Continued.

Variety.	Serial number.	Ash.	Albuminoids.	Nitrogen.
		Per cent.	*Per cent.*	*Per cent.*
Colorado:				
Yellow Dent	1985	1.92	9.10	1.46
White Dent	1986	3.08	12.25	1.96
Yellow Dent	1987	2.06	9.28	1.48
Do	1988	1.85	8.93	1.43
California:				
White Flint	2296	1.70	11.73	1.88
Yellow Dent	2297	1.35	9.80	1.57
White Dent	2298	1.80	11.73	1.88
Yellow Dent	2299	1.41	8.40	1.34
White Dent	2300	1.68	11.38	1.82
Yellow Dent	2301	1.46	10.68	1.71
Mixed Dent	2302	1.59	9.63	1.54
White Dent	2303	1.54	9.63	1.54
Do	2304	1.58	10.33	1.65
Do	2305	1.63	9.80	1.57
Yellow Dent	2306	1.45	9.80	1.57

Analyses of corn from other sources than the Department of Agriculture, arranged by States.

Name.	Variety.	Date.	Water.	Ash.	Oil.	Carbhydrates.	Fiber.	Albuminoids.	Nitrogen.	Analyst.
Massachusetts:			*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
Waushakum	Flint		13.05	1.29	4.06	69.80	1.11	10.69	1.71	United States Census.
Wheeler's Prolific	...do		12.69	1.39	4.58	67.46	1.82	12.06	1.93	Massachusetts Rep't, 1879.
Clark	...do		12.12	1.64	4.75	66.91	2.40	12.12	1.94	Do.
Tip	...do		8.86	1.57	5.26	68.93	2.53	12.85	2.06	Do.
Canada	...do		13.44	1.27	4.56	66.31	2.40	12.02	1.92	Do.
Canada Dutton	...do		14.36	1.42	5.00	66.51	2.38	10.33	1.65	Do.
Massachusetts Red	...do		11.95	1.10	3.40	69.47	2.02	12.06	1.93	Sharples.
Massachusetts White	...do		10.22	1.44	3.40	74.24	1.47	9.22	1.48	Do.
Early Southern	Dent		12.97	1.64	4.83	66.62	2.41	11.54	1.86	Massachusetts Rep't, 1879.
Golden Eight-rowed	Unclassified		12.51	1.58	4.94	69.37	1.35	10.25	1.64	Sharples.
Connecticut:										
White Pop-corn	Flint	1876	11.84	1.24	4.92	71.09	1.22	9.69	1.55	United States Census.
King Philip	... do		15.97	1.35	4.50	66.50	1.37	10.31	1.65	Connecticut Report, 1880.
Common Yellow	...do		15.77	1.26	4.44	67.06	1.47	10.00	1.60	Do.
White	...do		16.82	1.19	3.89	67.84	1.32	8.94	1.43	Do.
Early Scioto	Dent		15.24	1.28	3.80	69.78	1.59	8.31	1.33	Do.
New York, White, Yellow Pop-corn	Flint	1879	12.55	1.28	4.18	70.49	1.16	10.34	1.65	United States Census.
South Carolina, Southern White	...do		9.86	1.37	4.48	69.78	2.03	12.47	2.00	Massachusetts Rep't, 1879.
Illinois:										
Western White	Dent		10.77	1.35	4.23	69.72	2.47	11.46	1.83	Do.
Western Yellow	...do		11.90	1.41	4.46	68.39	2.95	10.89	1.74	Do.
	Unclassified		13.61	1.35	3.62	69.10	3.13	9.19	1.47	Sharples.
Minnesota, Yellow Dent	Dent		12.14	1.63	4.25	70.86	1.62	9.50	1.52	United States Census.
New Mexico:										
White	Unclassified	1879	10.92	1.58	5.59	70.10	1.75	10.06	1.61	Do.
Red	... do	1879	10.85	1.60	5.89	68.97	1.60	11.09	1.77	Do.
California, Yellow Dent	Dent	1879	11.42	1.37	5.18	69.16	1.56	11.31	1.81	Do.
Unclassified:										
Western corn	Unclassified		20.68	1.19	3.70	64.95	1.65	7.83	1.25	Connecticut Report, 1880.
Do	...do		20.22	1.16	3.55	64.86	1.67	8.54	1.37	Do.
Do	...do		16.41	1.25	3.85	68.16	1.76	8.57	1.37	Do.
Kansas corn	...do		11.34	1.07	4.60	72.90	1.28	8.81	1.41	Sharples.
Sweet corn:										
Blue Texas	Massachusetts		7.74	1.60	8.70	65.54	2.56	13.86	2.22	Massachusetts Rep't, 1879.
Crosby	...do		10.50	1.77	6.91	66.75	2.47	11.60	1.86	Do.
Sweet	Connecticut	1877	10.09	2.08	8.22	61.78	2.52	15.31	2.45	Connecticut Report, 1878.
Burr's Sweet	Sweet		10.68	2.22	7.77	62.70	4.94	11.69	1.87	Sharples.

Average composition of American corn.

Locality, &c.	Ash.	Albuminoids.	Nitrogen.	Number of analyses.	Lowest albuminoids.	Highest albuminoids.
	Per cent.	*Per cent.*	*Per cent.*		*Per cent.*	*Per cent.*
America, 1882	1.52	10.46	1.67	114	7.00	13.05
America, 1883	1.58	10.31	1.65	88	7.88	12.63
Average	1.55	10.39	1.66	202	7.00	13.65
New York	1.43	10.54	1.69	9	9.10	12.43
Illinois	1.48	10.06	1.61	20	7.88	12.08
Minnesota	1.68	10.07	1.61	16	8.40	12.43
Dakota	1.57	10.75	1.72	15	9.28	12.25
Nebraska	1.54	10.47	1.68	13	9.10	12.25
Colorado	2.23	9.89	1.58	4	8.93	12.25
California	1.56	10.26	1.64	11	8.40	11.73

Among the determinations of the ash and nitrogen in the crop of 1883, given in the preceding tables, there is as little variation as in previous analyses, and the conclusions derived from the latter are confirmed. The average of all the determinations for each year and for both together vary only in the hundredths of a per cent. Corn may be said, therefore, without doubt, to be very constant in its composition within narrow limits. An occasional exception will no doubt appear, as is the case of the ash in serial No. 1986, from Colorado, which rises to 3.08 per cent., but among over two hundred analyses this is hardly remarkable.

The averages for the States, as would be expected, agree well. Colorado is represented by only four specimens, which happen to be below the average, while California, represented by eleven, raises the average for the Pacific slope, which, in the previous report, after the analyses of two specimens from Oregon, appeared very low.

Such analyses by other investigators as have been collected since the appearance of the last bulletin on this subject appear here in a table by themselves. The results there given coincide with our own.

Previous results showed that corn varied in weight from 53 grains per hundred kernels to 23 grains, averaging about 37. How far locality and surroundings influenced this has been to a degree determined by the examination of specimens collected by the agents of the Department from all parts of the Union.

The averages of the results given in our original report follow:

Corn, average weight of 100 *kernels.*

DENT.

Locality.	No of samples.	Average.	Highest.	Lowest.
		Grams.	*Grams.*	*Grams.*
United States	1,009	36.7475	64.1020	13.8586
Middle States	34	30.6963	58.1560	27.4900
Southern States	427	40.8233	64.1020	15.5040
Northern Central States	177	33.5430	51.2106	13.8586
Northwestern States	140	29.1013	47.2490	16.0737
Southwestern States	202	39.8208	57.6890	22.2990
Mountain region	10	32.3279	39.1460	16.8545
Pacific States	18	34.7727	49.1130	21.6030
New York	2	31.0393	33.3200	28.7586
Pennsylvania	12	34.9457	41.3560	27.4900
New Jersey	5	44.2956	56.6640	35.7330
Maryland	15	42.7112	58.1560	34.0010
Virginia	54	43.2024	59.7100	24.1600
West Virginia	27	39.2584	50.8610	26.7720
Kentucky	54	42.4498	60.9090	28.0280
Tennessee	60	45.2508	64.1020	29.6330
North Carolina	58	42.6440	60.6360	30.1470
South Carolina	17	37.3088	54.6680	27.1930

DENT.

Locality.	No. of samples.	Average.	Highest.	Lowest.
		Grams.	*Grams.*	*Grams.*
Georgia	72	39. 6891	63. 1250	25. 1970
Florida	8	33. 6086	44. 1160	26. 7860
Alabama	36	37. 9630	56. 6144	21. 1625
Mississippi	29	36. 0731	55. 2550	22. 7770
Louisiana	22	31. 9912	39. 7050	15. 5040
Michigan	10	31. 4784	42. 6000	20. 9080
Wisconsin	1	22. 3190	....	....
Ohio	52	32. 4428	43. 8076	21. 1618
Indiana	55	34. 2614	51. 2106	13. 8586
Illinois	59	34. 3831	46. 8000	22. 6770
Minnesota	27	24 0159	39. 8516	16. 0737
Dakota	24	26. 1268	37. 2568	18. 5560
Iowa	47	31. 7087	45. 3770	22. 9360
Nebraska	42	33. 5332	47. 2490	22. 1462
Missouri	58	40. 9470	57. 6890	26. 3210
Arkansas	35	41. 3725	55. 5810	33. 2310
Kansas	44	39. 8887	55. 1700	24. 2170
Indian Territory	4	41. 6155	48. 2520	32. 8680
Texas	61	37. 6929	57. 2310	22. 2090
Colorado	7	28. 3356	39. 1460	16. 8545
Utah	3	29. 9303	37. 5040	17. 8290
New Mexico	1	35. 1530	....	....
Washington Territory	1	28. 0380	....	....
Oregon	4	35. 4732	43. 3380	30. 1540
California	13	34. 9905	49. 1130	21. 6030

FLINT.

Locality.	No. of samples.	Average.	Highest.	Lowest.
United States	81	32. 6254	54. 4970	17. 6820
New England States	15	32. 0839	51. 7450	17. 7670
Middle States	29	32. 9688	54. 4970	18. 6986
Southern States	5	33. 5484	41. 6220	25. 4800
Northern Central States	6	30. 9293	35. 6920	26. 8200
Northwestern States	10	30. 1772	41. 2822	17. 6820
Southwestern States	2	28. 8645	29. 3970	28. 3320
Mountain region	7	35. 0963	46. 9960	25. 7850
Pacific States	8	33. 6780	44. 4785	24. 5209
Maine	6	30. 4801	41. 7080	21. 3015
New Hampshire	1	17. 7670	....	....
Vermont	2	28. 4020	30. 1690	26. 6350
Massachusetts	5	39. 2321	51. 7450	28. 7824
Connecticut	1	37. 6470	....	....
New York	22	30. 2896	43. 1110	18. 6986
Pennsylvania	3	38. 4430	43. 7330	35. 6170
New Jersey	2	41. 9360	46. 2980	37. 5740
Maryland	2	45. 2660	54. 4970	36. 0350
Kentucky	1	39. 7160	....	....
South Carolina	1	31. 5070	....	....
Georgia	2	33. 5510	41. 6220	25. 4800
Louisiana	1	29. 4170	....	....
Michigan	6	30. 9293	35. 6920	26. 8200
Minnesota	7	30. 2036	41. 2822	17. 6820
Dakota	2	31. 4166	32. 1986	30. 6346
Montana	1	26. 5140	....	....
Kansas	1	28. 3320	....	....
Texas	1	29. 3970	....	....
Colorado	1	41. 1520	....	....
Utah	4	34. 1817	46. 9960	25. 7850
New Mexico	2	33. 8975	35. 0450	32. 7500
Washington Territory	2	44. 1457	44. 4785	43. 8130
Oregon	2	30. 3595	35. 7600	24. 9590
Nevada	1	27. 1390	....	....
California	3	31. 0915	33. 2986	24. 5209

DENT AND FLINT.

Locality.	No. of samples.	Average.	Highest.	Lowest.
United States	7	34. 8330	41. 2140	28. 0200
Southern States	5	33. 8363	40. 4520	28. 0200
Southwestern States	1	41. 2140	....	....
Mountain region	1	33. 4360	....	....
Virginia	2	34. 2360	40. 4520	28. 0200
North Carolina	1	33. 2440	....	....
Florida	1	31. 1340	....	....
Alabama	1	36. 3313	....	....
Texas	1	41. 2140	....	....
New Mexico	1	33. 4360	....	....

As regards variety, the Dent, as would be expected, averages heavier per hundred kernels than the Flint, and with it also lie the extremes of weight, 64 grams per hundred and thirteen. In southern latitudes the Dent kernels are much heavier than in the northern, between the Middle States and the Southern there being a difference of ten grams per hundred. In New England Dent corn is hardly ever raised, but the Flint which is raised nearly equals in weight the Dent of Pennsylvania. Conversely, Flint only is raised in the North and Northwest, and there excels in weight.

The heaviest corn comes from Virginia, North Carolina, Kentucky, and Tennessee, and from the last-named State the heaviest single specimens. The weight per hundred kernels in the larger corn-producing States averages about thirty-two grams (or an ounce), Missouri being somewhat higher—forty grams.

CHEMISTRY OF THE ROLLER MILLING PROCESS OF GRADUAL REDUCTION.

It is the object of milling to reduce the floury portion of the wheat-grain to the finest possible form without injuring its physical condition, and at the same time with complete exclusion of portions of the bran and germ, and such refuse products as would injure its baking qualities and color. An examination of the structure of the grain will enable us to understand the difficulties to be met and the way in which the different products which have been analyzed are obtained.

If a blade of wheat were much thickened and the two halves then folded back upon themselves a transverse section of it would represent a similar section of the grain; that is to say, the two lobes would meet, forming what is known in the grain as the crease within which would be inclosed and hidden a portion of the outer covering. This explains how difficult it is in preparing the wheat for milling to remove all the foreign matter which this crease contains. On the exterior of the grain there is found toward one end a collection of hair, and at the other end appears the embryo, or germ. A longitudinal section shows both of these undesirable additions to the floury matter of the grain. Aside from its exterior appearance the wheat-grain is essentially an embryo, the germ, together with a supply of food, the endosperm or floury matter, surrounded by several membranes or coats of greater or less importance. On the exterior is the first membrane, or cuticle, a very thin coating, easily removed by rubbing. Next follows a more important, because thicker, portion of the outer covering, consisting of two layers of cellular tissue, the *epicarp* and *endocarp*. These three membranes together form the outer covering of the grain, and from one of them, the epicarp, spring the hairs which are found on one end. These envelopes are colorless and very light, constituting only from 3 to 3½ per cent. of the whole, and are more or less easily removed by friction. From an examination of a section of the grain, it is seen that within the crease this is of course impossible, so that while the preparation of the wheat for milling may remove the hairs and much of the cuticle and dirt it cannot completely free it from them. It is this inherent difficulty that the roller mills attempt to overcome by splitting the grain along the crease and afterwards cleaning it with brushes.

Under these outer coverings are three membranes, known as the *testa* or *episperm*, the *tegmen*, and the *embryous envelope*. The testa is a compact affair, and carries the coloring matter of the bran. The tegmen is

an extremely thin membrane, not easily seen except where it becomes thick, and just under the testa in the heart of the crease. It is not of importance from a milling point of view. The testa and tegmen form about 2 per cent. of the grain.

The *embryous membrane* is a continuation of the embryo around the endosperm or floury portion of the grain. It is composed of cells which are often erroneously termed gluten cells, but the true gluten cells are scattered through the endosperm. The cells of the embryous membrane contain little or no gluten, and as they are a continuation of the embryo, it must be nearly as undesirable to allow them in the finished flour as the germ itself.

The endosperm is by far the largest portion of the grain, and it is that which is the object of all milling processes to separate from the rest of the wheat and grind to flour.

It consists of large cells containing the granules of starch and the gluten. At the exterior, nearer the embryous membrane, it is much harder than in the center and contains much more gluten. In all methods of gradual reduction, therefore, the center is of course reduced first, and, being very starchy, is only fit for a low-grade flour, while the richest part of the endosperm, being harder and closely attached to the tough bran coats, is to a certain extent lost, or so contaminated with small pieces of the bran as to injure the color of the flour, furnishing what is known as bakers' grades.

By the old-fashioned low-milling process, or grinding between stones placed very close together and bolting, it was impossible to obtain a flour entirely free from contamination. The advance to high milling, with stones far apart, allowing the middlings which were produced to be purified before grinding to flour, was a step which made it possible to make from winter wheat an excellent and pure flour. When, however, spring wheat, with its hard and brittle outer coats, became important commercially, it was necessary to resort to the roller methods of milling, which, in conjunction with peculiar purifying machinery, would furnish a flour free from all undesirable impurities.

This process is so complete that an examination and chemical analysis of the products are of great interest, as showing how the different constituents of the grain are divided. It is unnecessary, however, to describe the process itself, long accounts of which can be found in the millers' journals of the day and in the Census of 1880, Vol. III, Statistics of Agriculture. It is sufficient merely to know the names of the products and the portion of the grain from which they come.

The first series, consisting of seventy-two specimens, is from the mill of C. A. Pillsbury & Co., Minneapolis, Minn., known as the Pillsbury "A." This mill, it may be of interest to know, is described in the census report previously mentioned. It uses the "*hard spring wheat*," which is grown in the Northwest, and its products, therefore, are typical of this particular variety.

The second partial series is from the mill of Herr & Cissel, in Georgetown, D. C., and the wheat used at the time the specimens were collected was a mixture of Virginia "*Fultz*" and "*Longberry*." Their products are illustrative, therefore, of the effect of the roller process on Virginia winter wheat.

The third partial series consists of a few specimens resulting from the milling of Ohio winter wheat by Warder & Barnett, of Springfield, Ohio, by the same methods as the others.

The Minnesota samples, being more numerous, will be taken up first.

PARTS OF THE WHEAT GRAIN IN DIFFERENT MILL PRODUCTS.

2001. *Wheat as it enters the mill.*—The whole wheat grain mixed with cockle, oats, and other foreign seed, as it comes from the thrasher.

2002. *Wheat prepared for the rolls.*—The foreign seeds have been removed, with the exception of a few grains of cockle and oats. The cockle is therefore to be found in subsequent parts of the process. The hairs have been largely rubbed off, together with portions of the cuticle. Some hairs are, however, still left, and portions of the cuticle remain attached and semi-detached, especially toward the crease. The grain as a whole presents a changed and much cleaner appearance.

2003. *Cockle and screenings.*—Among the foreign seeds there are found principally cockle and a species of polygonum and oats, together with broken pieces of wheat, dirt, chaff, &c.

2004. *Scourings removed by cleaners.*—These consist almost entirely of cuticle and hairs, but portions of epicarp, with the hairs still adherent, and of endocarp are present. Treatment with iodine reveals a small amount of endosperm or starch, and shows the inner part of the outer coats of the grain are the most highly nitrogenous. The contrast between the embryous membrane and endocarp and the epicarp and cuticle is prominent. The embryous membrane is recognized by its roundish cells; the endocarp by its transverse cells, twice as long as broad, and packed closely and regularly, like cigars, which has given it the name of cigar-coat, and the epicarp by its very long and irregular cells arranged longitudinally, the cuticle being of a similar sort.

2005. *First break.*—The grain is split along the crease normally into two halves, but also frequently into fours, or even more irregularly. The glistening, hard, floury endosperm makes its appearance for the first time. Comparatively little flour or dust is made.

2006. *Chop from first break.*—This consists principally of endosperm, but small portions of bran* and germ are present, the former including all the various outer coats.

2007. *Second break.*—In this break the greater part of the endosperm is separated from the bran, and is seen as large well-shapen middlings, together, of course, with some small stuff and dust.

2008. *Chop from second break.*—This is chiefly endosperm, with somewhat less bran than the previous chop. Whole germs and parts are numerous. The endosperm is of all sizes, but the greater portion of large angular fragments. The bran includes portions of all the outer coverings, while dusty matter and starch grains are quite abundant.

2009. *Third break.*—The endosperm is so completely separated in this break that it only remains in scattered patches upon the bran, and the embryous membrane is quite visible.

2010. *Chop from third break.*—The middling or particles of endosperm are much finer, and there is more dust. Small portions of germ are plentiful. The branny particles are similar in nature to those in the last chop but smaller, and there is more dust of a nitrogenous kind.

2011. *Fourth break.*—Only to be distinguished from No. 2009 by the slightly cleaner bran.

2112. *Chop from fourth break.*—Not very different in appearance from 2010, except that it is composed of more finely divided particles.

2013. *Fifth break.*—Still cleaner bran than 2011. It still holds a very appreciable portion of endosperm.

2014. *Chop from fifth break.*—Chop contains a great deal of branny matter, including pieces of epicarp, endocarp, and embryous membrane. The endosperm is very fine and much mixed with germ. Of course in all these products portions of the testa and tegmen are present, but they are not easily seen except in careful preparations.

2015. *Sixth break.*—Barely distinguishable from bran.

2016. *Chop from sixth break.*—Very largely made up of small pieces of branny material and germs. The endosperm which is present is very fine.

2017. *Bran.*—This is composed practically of epicarp, endocarp, and embryous membrane, the cells of the latter having been very little disturbed. There is still a little cuticle and endosperm left, but they have mostly disappeared in previous operations.

2018. *Shorts.*—These are made up of all the different parts of the grain in rather a fine condition, some of the branny particles having endosperm still adherent to them.

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* Bran is used in this description as denoting and including any part of the coats of the grain.

2019. *Middlings, Uncleaned No.* 1.—These are the largest sized middlings, and consist in themselves of clean, angular fragments of endosperm, but they are mixed with considerable shorts and many whole and broken germs. They are the most impure of the five, and an analysis will show this fact.
2020. *Middlings, Uncleaned No.* 2.—All the particles are finer than in the previous middlings, and less germ and bran is present, which will produce a corresponding change in their chemical composition.
2021. *Middlings, Uncleaned No.* 3.—Still finer than No. 2, and less bran and germ.
2022. *Middlings, Uncleaned No.* 4.—Finer than No. 3, and less bran and germ.
2023. *Middlings, Uncleaned No.* 5.—The finest of all the middlings, with almost no bran and germ. The effect of cleaning will be small.
2024. *Middlings, Cleaned No.* 1.—Many of the lighter particles of bran removed, but there is much remaining, as well as of the germ.
2025. *Middlings, Cleaned No.* 2.—The bran is to a large degree removed in cleaning these middlings, but the germ of course remains.
2026. *Middlings, Cleaned No.* 3.—The bran is almost all gone.
2027. *Middlings, Cleaned No.* 4.—These middlings are practically quite clean and pure endosperm. Only here and there a particle of bran or germ.
2028. *Middlings, Cleaned No.* 5.—Quite clean, and very small in size.
2029. *First middlings, reduction on smooth rolls.*—The germ is flattened, and the endosperm reduced in size.
2030. *Chop from first reduction of middlings.*—This sample appears to be misplaced, as it contains much bran and germ.
2031. *Second middlings, reduction on smooth rolls.*—A sample of this reduction was not furnished.
2032. *Chop from second reduction of middlings.*—This chop contains a few particles of bran and germ.
2033. *Third middlings, reduction on smooth rolls.*—The germ is prominent in its flattened condition.
2034. *Chop from third reduction of middlings.*—The bran and germ have been almost entirely removed.
2035. *Fourth middlings, reduction on smooth rolls.*—Like the middlings themselves, merely reduced in size.
2036. *Chop from fourth reduction of middlings.*—Here and there a small particle of bran seen.
2037. *Fifth middlings, reduction on smooth rolls.*—Resembles of course the fifth middlings.
2038. *Chop from fifth reduction of middlings.*—This is not as white as the chop from the fifth reduction, as it contains bran and germ in small quantities.
2039. *Flour from the first reduction.*—The grains of endosperm are clean and sharp.
2040. *Flour from the second reduction.*—The grains are not as sharp as those from the first reduction.
2041. *Flour from the third reduction.*—Very much like the flour from the second reduction, but perhaps a little lumpier.
2042. *Flour from the fourth reduction.*—More coherent and yellower than previous flours.
2043. *Flour from the fifth reduction.*—There is no specimen of this flour.
2044. *Tailings from middlings purifier No.* 1.—These tailings are coarse. They contain much bran, mixed with germ, and a considerable amount of large middlings.
2045. *Tailings from middlings purifier Nos.* 2, 3, *and* 4.—Much finer than the previous tailings and freer from germ and endosperm.
2046. *Tailings from middlings purifier No.* 6.—Largely composed of fine endosperm, mixed with bran and germ.
2047. *Tailings from the first reduction.*—These are made up of about equal parts of fine endosperm and of bran and germ.
2048. *Tailings from the second reduction.*—These are finer than the first tailings, and contain more germ. There are also present pieces of endosperm, flattened like the germ.
2049. *Tailings from third reduction.*—Still finer, with much flattened endosperm, and less grain and bran.
2050. *Tailings from fourth reduction.*—Very finely divided and flattened endosperm, with only about 10 per cent. of bran and germ. This should be very evident in the analysis.
2051. *Tailings from fifth reduction.*—Coarser than the fourth tailings, and like the third in quality.
2052. *Repurified middlings.*—Coarse pieces of endosperm, with much bran and germ.
2056. *Bakers' flour.*—Slightly yellow in color. The grains lack distinctness, making the flour lumpy.
2057. *Patent flour.*—A clear white grain.
2058. *Low-grade flour.*—The grain is soft and the flour dark and lumpy. Particles of bran and germ are prominent.

2059. *Break flour.*—Physically like the bakers' grade in appearance, but particles of bran and germ are present, making it of less value.
2060. *Stone flour.*—This flour is white, of a fair grain, with a very little bran.
2062. *Flour from first tailings.*—A very good, free grain, but a little branny.
2063. *Flour from third tailings.*—A free grain, but quite branny and yellow.
2064. *Flour from second tailings.*—This flour resembles that from the first tailings, but contains more bran and is yellower.
2070. *First germ.*—This is made up of the finest particles of germ, and contains the largest proportion of middlings and bran.
2071. *Second germ.*—The largest particles of germ, with little bran and endosperm.
2072. *Third germ.*—A medium between the two former.
2074. *Bran-duster flour.*—This is black in color and lumpy. It has little grain and a small portion of bran.
2077. *Stone stock No.* 2.—A good middling, with a little bran and germ.
2078. *Stone stock No.* 3.—This is not as good as No. 2, and holds more bran and germ.
2083. *Tailings from sixth break.*—This is made up of about half barley shaped and flattened pieces of endosperm, the rest being bran, with a little germ.
2084. *Tailings from first centrifugal reel.*—Largely flattened endosperm; the rest germ, with a little bran.
2085. *Tailings from second centrifugal reel.*—These are largely bran and flattened endosperm with a little germ.
2086. *Tail end of the tailings.*—As would be expected, almost entirely bran, with a little adherent endosperm and a small amount of germ. The embryous membrane is still in place; in fact during the whole process there is very little of it removed from the bran, and were it the chief source of gluten, there would be very little in any of the products. This, however, is not the case. It contains little or no gluten, being merely a continuation of the germ and having a similar composition.
2087. *Dust from No.* 1 *middlings.*—This is mostly cuticle epicarp and hairs, with smaller amounts of the more interior parts of the grain.
2088. *Dust from the dust-catcher.*—This is all light, fluffy matter, and is made up of small particles from all parts of the grain.

These observations upon the proportions in which the different portions of the grain enter into the various products enable us to understand and interpret the chemical analyses which follow with greater clearness than could otherwise be done, and it will be seen afterward that with a knowledge of the constituents of the different parts, of bran, the germ, and the endosperm, it is comparatively easy to predict almost the exact composition of any of the mill products from the above data.

Analyses of the products of roller milling.

Serial number.	Names.	Water.	Ash.	Oil.	Carbhydrates.	Fiber.	Albuminoids.	Nitrogen.	Phosphoric acid.	Ratio nitrogen to phosphoric acid.	Gluten. Moist.	Gluten. Dry.
	C. A. PILLSBURY & CO., MINNEAPOLIS, MINN.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
2001	Wheat as it enters the mill	9.66	1.91	2.61	69.94	1.70	14.18	2.27	.82	2.77		
2002	Wheat prepared for the rolls	9.07	1.79	2.74	70.37	1.68	14.35	2.30	.82	2.80	32.31	11.88
2003	Cockle and screenings	9.03	2.65	4.32	66.12	4.23	13.65	2.18	.78	2.80		
2004	Scourings removed by cleaners	9.27	3.68	3.73	70.19	1.58	11.55	1.85	.76	2.43		
2005	First break	8.23	1.73	2.68	71.56	1.62	14.18	2.27	.91	2.49	31.92	11.69
2006	Chop from first break	12.52	.88	2.08	70.44	1.13	12.95	2.07	.46	4.50	34.10	12.27
2007	Second break	8.37	2.04	2.47	71.47	1.65	14.00	2.24	.98	2.29	32.78	11.80
2008	Chop from second break	12.78	.57	1.68	71.82	.55	12.60	2.04	.34	5.94	36.88	12.56
2009	Third break	9.92	2.55	5.25	65.10	2.13	15.05	2.41	1.33	1.81	32.09	12.04
2010	Chop from third break	12.70	.78	1.86	71.10	.78	12.78	2.04	.42	4.86	37.19	13.00
2011	Fourth break	8.18	3.30	4.09	66.20	3.00	15.23	2.44	1.44	1.07	27.88	10.54
2012	Chop from fourth break	12.35	1.47	2.87	67.90	1.23	14.18	2.27	.75	5.05	30.52	11.64
2013	Fifth break	7.62	5.16	4.91	61.76	4.80	15.75	2.52	2.58	.98		
2014	Chop from fifth break	11.91	1.99	4.16	64.46	1.73	15.75	2.52	1.01	2.49	27.97	11.82
2015	Sixth break	7.66	5.68	5.34	59.42	5.60	16.28	2.60	2.95	.81		
2016	Chop from sixth break	11.84	3.29	4.92	59.09	3.18	17.68	2.83	1.66	1.70	24.04	10.69
2017	Bran	10.91	5.59	5.03	56.21	5.98	16.28	2.60	2.78	.94		
2018	Shorts	10.94	3.41	4.07	60.28	3.90	16.80	2.69	1.62	1.66		
	Middlings uncleaned:											
2019	No. 1	12.71	1.27	2.73	68.78	1.03	13.48	2.16	.64	3.39	29.68	10.57
2020	No. 2	12.18	1.04	2.16	70.49	.83	13.30	2.13	.54	3.94	32.99	11.49
2021	No. 3	12.27	.70	1.80	71.52	.58	13.13	2.10	.36	5.83	35.52	12.21
2022	No. 4	12.47	.68	1.75	70.69	.58	13.83	2.21	.40	5.52	45.62	15.69
2023	No. 5	12.34	.61	1.75	70.24	.53	14.53	2.32	.33	7.03	43.82	14.86
	Middlings cleaned:											
2024	No. 1	12.67	1.07	2.12	70.16	.85	13.13	2.10	.59	3.56	34.03	11.16
2025	No. 2	9.93	.65	1.90	74.09	.65	12.78	2.04	.33	6.18		
2026	No. 3	12.36	.59	1.70	71.67	.55	13.13	2.10	.24	8.75	44.43	14.99
2027	No. 4	12.51	.52	1.77	71.57	.33	13.30	2.13	.29	7.34	51.93	17.85
2028	No. 5	12.35	.51	1.62	70.74	.43	14.35	2.30	.23	10.00	46.15	14.87
	Middlings, reduction on smooth rolls:											
2029	First middling	12.64	.82	2.56	70.80	.58	12.60	2.02	.46	4.39	34.29	11.57
2030	Chop from first middling	12.74	.72	1.99	71.72	.58	12.25	1.96	.40	4.90	32.16	10.91
2031	Second middling											
2032	Chop from second middling	12.48	.57	1.68	71.24	.38	13.65	2.18	.34	6.41	41.36	13.65
2033	Third middling	12.29	.61	1.86	71.91	.55	12.78	2.04	.34	6.00	36.70	11.81
2034	Chop from third middling	12.73	.79	2.01	71.29	.58	12.60	2.02	.43	4.70	34.58	11.68
2035	Fourth middling	11.43	.56	1.86	73.12	.43	12.60	2.02	.34	5.94	37.00	12.23
2036	Chop from fourth middling	11.72	.50	1.76	72.56	.33	13.13	2.10	.27	7.78	42.06	12.32

2037	Fifth middling	12.21	.65	2.08	71.85	.43	12.78	2.04	.40	5.10	36.25	11.97
2038	Chop from fifth middling	11.47	.56	2.03	72.66	.50	12.78	2.04	.37	5.57	40.84	12.11
	Flour from reduction of fifth middlings:											
2039	First	12.03	.39	1.58	73.70	.25	12.05	1.98	.24	8.04	31.51	10.97
2040	Second	12.42	.44	1.66	72.55	.33	12.60	2.02	.24	8.42	37.04	12.07
2041	Third	11.54	.38	1.36	75.24	.28	11.20	1.79	.19	9.42	32.54	10.90
2042	Fourth	11.58	.40	1.42	72.92	.38	13.30	2.13	.20	10.65	37.90	12.52
2043	Fifth											
	Tailings from middlings purifiers:											
2044	No. 1	12.33	3.30	4.96	60.06	3.25	16.10	2.55	1.61	1.60		
2045	Nos. 2, 3, and 4	11.59	3.09	3.92			14.53	2.32	1.30	1.67	12.28	7.63
2046	No. 6	12.00	.90	2.37	69.10	1.10	14.53	2.32	.49	4.78	30.88	14.37
	Tailings from reduction:											
2047	First	11.78	3.26	5.03	60.32	2.63	16.98	2.72	1.82	1.47	13.04	5.47
2048	Second	10.35	3.38	4.37	59.87	2.08	19.95	3.19	1.68	1.90		
2049	Third	11.72	2.35	4.37	63.27	1.66	16.63	2.66	1.34	1.98		
2050	Fourth	12.09	.88	4.16	68.47	.40	14.00	2.24	.48	4.67	35.73	13.34
2051	Fifth	12.12	2.29	3.85	63.93	1.18	16.63	2.66	1.35	1.97	1.89	.67
2052	Repurified middlings	11.72	2.11	3.07	65.99	1.63	14.88	2.38	1.21	1.98	28.17	10.74
	Finished flour:											
2056	Bakers'	12.18	.62	2.00	69.99	.33	14.88	2.38	.31	7.68	51.21	16.97
2057	Patent	11.48	.39	1.45	73.55	.18	12.95	2.07	.18	11.50	36.14	10.85
2058	Low grade	12.01	1.99	3.86	63.26	.93	17.95	2.74	1.16	2.36	10.01	4.26
2059	Break flour	12.48	.58	1.87	69.44	.23	15.40	2.46	.31	7.94	51.88	15.87
2060	Stone flour	12.04	.49	1.61	72.85	.23	12.78	2.04	.27	7.55	38.21	11.74
	Flour from tailings:											
2062	First	12.55	.62	2.93	70.25	.35	13.30	2.13	.30	7.10	39.13	12.85
2063	Third	12.50	.85	2.79	70.20	.53	13.18	2.10	.45	4.67	37.78	12.68
2065	Second	11.20	.76	2.63	72.28	.48	13.65	2.18	.39	5.59	43.25	13.87
2068	Cockle chop	12.45	2.79	4.34	64.01	3.63	12.78	2.04	.86	2.37		
2069	Cockle bran	7.71	3.46	3.84	65.46	9.03	10.50	1.68	.83	2.02		
2070	First germ	8.69	3.42	9.35	53.28	1.23	24.13	3.86	1.83	2.11		
2071	Second germ	8.75	5.45	15.61	35.19	1.75	33.25	5.32	2.57	1.98		
2072	Third germ	7.68	4.94	13.75	39.25	1.50	32.88	5.26	2.56	2.05		
2074	Bran duster flour	11.78	1.17	2.70	70.20	.50	13.65	2.18	.66	3.30	58.50	13.72
	Stone stock:											
2077	No. 2	12.15	.40	1.64	72.91	.25	13.65	2.18	.19	11.58	47.55	15.32
2079	No. 3	12.01	.55	2.12	71.76	.43	13.13	2.10	.28	7.50	46.39	15.15
	Tailings:											
2083	From sixth break	11.64	2.29	4.06	64.31	1.95	15.75	2.52	1.23	2.05	16.45	6.17
2084	From first centrifugal reel	11.42	2.15	3.44	66.56	1.20	15.23	2.44	.98	2.49	6.58	2.39
2085	From second centrifugal reel	11.07	2.85	4.73	61.82	2.20	17.33	2.79	1.47	1.88		
2086	Tail end of the tailings	11.36	3.87	5.23			15.75	2.52	1.75	1.44	10.74	4.41
2087	Dust from No. 1 middlings	11.03	1.83	2.73	64.86	5.20	14.35	2.30	.55	4.18	25.78	10.31
2088	Dust from dust catcher	11.53	1.17	2.64	69.01	1.65	14.00	2.24	.55	4.07	35.05	13.00
	HERR & CISSEL, GEORGETOWN, D. C.											
2089	Mixed wheat, clean	9.62	1.93	2.29	71.83	1.55	12.78	2.04	.98	2.08	30.00	11.03
2090	First break	8.13	2.03	2.46	72.30	1.60	13.48	2.16	1.05	2.05	29.17	10.42
2091	Second break	9.47	2.00	2.01	71.81	1.58	13.13	2.10	.91	2.30	34.02	11.87
2092	Third break	8.79	2.03	2.37	71.98	1.70	13.13	2.10	1.10	1.90	29.24	10.32

Analyses of the products of roller milling—Continued.

Serial number.	Names.	Water.	Ash.	Oil.	Carbhydrates.	Fiber.	Albuminoids.	Nitrogen.	Phosphoric acid.	Ratio nitrogen to phosphoric acid.	Gluten. Moist.	Gluten. Dry.
	HERR & CISSEL, GEORGETOWN, D. C.—Continued.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
2093	Fourth break	8.91	2.39	2.33	70.97	1.75	13.65	2.18	1.14	1.91	34.08	12.23
2094	Fifth break	7.18	3.46				15.40	2.46	1.35	1.82	26.75	10.09
2095	Sixth break	9.38	4.76				16.10	2.58	2.46	1.04		
2096	First middling	11.96	.49	1.22	75.30	.35	10.68	1.71	.25	6.84	32.99	9.92
2097	Second middling	11.89	.51	1.21	75.56	.33	10.50	1.68	.25	6.72	35.49	10.55
2098	Third middling	10.88	.50	1.19	75.45	.25	11.73	1.88	.24	7.83	42.10	13.32
2999	First middling through smooth rolls	9.87	1.84	2.00	71.08	1.18	13.13	2.10	.87	2.42	28.97	10.59
2100	Patent flour	12.98	.32	.92	75.60	.20	9.98	1.60	.16	10.00	20.55	9.08
2101	Bakers' flour	13.20	.47	1.26	72.45	1.50	11.03	1.76	.28	6.28	35.04	11.30
2102	Low-grade flour	12.59	1.05	2.33	69.10	.75	14.18	2.27	.58	3.91	35.96	12.81
2103	Germ middlings	11.10	2.41	3.74	66.59	1.63	14.53	2.32	1.19	1.94		
2104	Feed middlings or tailings	8.53	3.75	4.96	62.21	4.10	16.45	2.63	1.98	1.32		
2105	Bran middlings	8.24	6.89	5.52	56.77	6.13	16.45	2.63	.98	2.68		
	WARDER & BARNETT, SPRINGFIELD, OHIO.											
1855	Wheat	9.05	2.06	2.46	71.67	2.33	12.43	1.99	1.03	1.93	20.93	10.34
1856	Patent flour	12.32	.34	1.05	75.28	.33	10.68	1.71	.19	9.00	35.52	10.76
1857	Bakers' flour	11.98	.60	1.77	71.52	1.00	13.13	2.10	.33	6.36	38.29	12.30
1858	Low-grade flour	12.36	.69	1.00	75.04	.93	9.98	1.60	.30	5.33	28.37	9.96
1859	Middlings	8.49	4.28	5.94	60.64	3.15	17.50	2.80	1.12	2.50		
1860	Bran	7.74	4.99	4.99			15.40	2.46	1.04	2.36		
2190	Patent flour, second sample	13.59	.36	1.08	73.94	.35	10.68	1.71				

The wheat as it enters the mill is subjected to a series of operations which removes dirt, foreign seed, the fuzz at the end of the berry, and a certain portion of the outer coats, through the agency of a run of stones and brushes. The result of this operation is to lower the amount of inorganic matter or ash, and to increase or decrease the other constituents but slightly, the albuminoids being a few tenths of a per cent. greater in amount. The point from which a convenient start may be made is at the first break.

The chop from the first rolls is very marked in its difference in composition from the original wheat. It of course has less fiber, and also, it is seen, less ash, oil, and albuminoids; in fact, it is starchy. It contains more water, owing to the fact that its comminution has allowed it to absorb the moisture from the air, and in general it will be observed that the coarser or more fibrous a specimen is the less water it contains, while the finer material holds more. For example, the percentage of water in several portions of the grain is as follows:

	Per cent.
Original grain	9.66
Ready for the break	8.23
Chop from first break	12.52
Fifth break	7.62
Bran	10.91

The heat caused by the friction of the process, of course, is an active agent, as may be seen on comparing the original grain and that ready for the break. The question of the relation of the various products to humidity is, however, considered in greater detail in another portion of this bulletin.

The starchy chop from the first break is carried off to the various purifying and grading machines, but for the present it will be left, as it is desirable to follow the breaks to the end.

The tailings from the first scalper, consisting of the wheat-grain split open along the crease, which serve to feed the second break after the cleaning which they undergo, vary but little from the wheat which goes to the first break. There are slight differences which must be attributed to the difficulty of selecting and preparing for analyses samples of the product of the different breaks, the finer chop having a tendency to sift out from the lighter bran, but they are not great enough to vitiate the conclusions. In the first break so little is done, except to crack open the wheat and clean it for the following rolls, that only a small change should be expected.

The chop from the second break is more from the center of the wheat-grain. It contains less ash, fat, and albuminoids than any of the break products, and includes, as was shown by our preliminary investigation, the greater portion of the endosperm.

The tailings supplying the third break already show, owing to the greater amount of chop produced on the second break, a marked increase in those constituents which are peculiar to the outer portions of the grain; that is to say, there has been a marked increase in ash, fiber, and albuminoids. This increase becomes still more apparent from break to break until the bran alone is left, which contains more ash and fiber than any other product of the wheat. The several chops increase in a like manner, the last or sixth break chop holding more albuminoids than the bran, and even any other of the resulting material. This is probably due to the comminution of the bran in the last break, and consequently, as will be seen, the middlings from this chop are richer

in nitrogen than any other, although not the richest in gluten, owing to the proportion of bran and germ which they contain.

Having followed the grain through the breaks to the bran, the products of the purification of the chop remain to be studied.

The shorts, or branny particles removed from the chop or from the middlings by aspirators, contain much less fiber and ash than the bran, although they are of similar origin, that is to say, from the outer coats of the grain. The analyses point to their origin from those portions of the coat which contain less ash and fiber.

The middlings are graded into five classes, and in their original uncleaned state they differ chemically in the fact that from No. 1 to No. 5 there is a regular decrease in ash, fiber, and fat, while No. 5 is richer in albuminoids than any other. This would be expected from our preliminary examination, which showed a decrease in bran from beginning to end, and that No. 5 was the purest endosperm.

After cleaning, the same relations hold good, but owing to the removal of the branny particles there is in all cases a loss of ash constituents and fiber. The effect of cleaning is more apparent in Nos. 1 and 2, where more bran is removed.

The reduction of the middlings on smooth rolls changes the composition but slightly, and the flours which originate from this process are very similar to the middlings from which they were produced. That from the fourth reduction is richer in nitrogen, as would also be the case with the fifth, although want of a specimen prevented an analysis.

The tailings from the middlings purifiers present the usual characteristics of by-products, which owe their existence to the outer part of the grain with its high percentages of ash and fiber, and, in this case also of nitrogen. It is remarkable, however, that the tailings marked No. 6 contain only one-third as much ash as the others, but this is explained by the fact that they are largely composed of endosperm.

The tailings from the different reductions are nearly alike in composition, with two exceptions: Those from the fourth contain little ash fiber and nitrogen. Like No. 6 of the purifier tailings, they consist largely of endosperm. Those from the second reduction contain much germ, and are therefore richer in nitrogen than the rest.

The repurified middlings, as might be expected, contain much more ash, oil, and fiber than the original, and there is also an increase in nitrogen but not in gluten, owing to the large amount of bran they contain.

Analyses of the three grades of flour as furnished to the market follow. From a cursory glance it might be said that the low-grade flour was the best, as it contains the most albuminoids, but its weakness is discovered in the fact that it has only 4 per cent. of gluten. The bakers' flour contains more ash, oil, fiber, albuminoids, and gluten than the patent, but owing to the increased amount of the first three constituents mentioned, it is proportionately lacking in whiteness and lightness. The two flours each have their advantageous points.

Several other grades of flour—break flour, stone flour, and flours from the first, second, and third tailings—are all very similar, and, as far as chemical analysis is concerned, good. The preliminary examination has, however, shown certain defects in each. The break flour is richer in albuminoids and gluten than any other, and if it were pure and its physical condition were good, it would be of value.

The roller process is distinguished for the completeness with which it removes the germ of the grain during the manufacture of flour by flattening and sifting it out. This furnishes the three by-products which

are known as first, second, and third germ. They consist of the germ of the wheat mixed with varying proportions of branny and starchy matter, the second being the purest. They all contain much ash, oil, and nitrogen, and if allowed to be ground with the flour blacken it by the presence of the oil and render it very liable to fermentation, owing to the peculiar nitrogenous bodies which it carries. A more complete analysis appears in another place.

The flour from the bran dusters is much like that from the tailings, and like the stone stock, from a chemical point of view. This merely shows that chemical evidence should not alone be taken into consideration, for the bran-duster flour is a dirty, lumpy by-product, while the stone stocks are valuable middlings. Analyses of various tailings are next in the series, and need no comment. Those of the dust from middlings and dust-catchers are rather surprising, in that they both contain much gluten and the first one much fiber, but this is due to their containing both bran and endosperm.

To follow the gluten through the process it is necessary to go back to the breaks. The amount in the various chops does not vary greatly. There is an apparent anomaly, however, in the fifth and sixth breaks, where no gluten was found in the feed, but much in the chop. This is owing to the fact that the feed has become at this point in the process so branny that by the usual method of washing to obtain the gluten it does not allow of its uniting in a coherent mass and separating from the bran.

Among the middlings, both uncleaned and cleaned, the fourth is the richest in gluten, and the result of the process of cleaning is to increase the amount, although slightly diminishing the nitrogen, which is due to the removal of the branny matter, which, though rich in nitrogen, is poor in gluten.

In the products of the reduction on smooth rolls, the chops from the higher middlings are the richest, and if the analyses of the flours were complete, No. 4 would probably contain more than the lower numbers.

The tailings are, as has been already said, remarkable, not so much that No. 1 has no gluten, but that Nos. 2, 3, and 4 have 7.62 per cent., and No. 6 as much as 14.37 per cent. The regular increase shows that the highest numbers must contain a large portion of endosperm.

That this is the case the microscopic examination of the different tailings has shown. No. 1 is found to consist almost entirely of the outer coatings of the grain; Nos. 2, 3, and 4 of the same mixed with a large proportion of endosperm, which is attached thereto, while in No. 6 it is difficult to discover any large amount of anything but flouring material, and the small percentage of ash shows also that it cannot contain much bran.

In a like manner No. 4 tailings from the reductions has 13.34 per cent. of gluten, which is owing to the large proportion of endosperm which it contains, and in this case, too, the fact of the presence of so much of the interior of the berry is presaged by the low percentage of ash. The remaining tailings of this class have little or no gluten, with the exception of No. 1, as they contain very little endosperm.

In connection with the remaining specimens the gluten has been already mentioned, and the results as a whole warrant the conclusion that less of it is wasted in the by-products than would be imagined. For a complete discussion of this point data, which are not at hand, in regard to the per cent. of each material produced, are necessary.

The products from Virginia wheat, similar to those which have just been described, present the same but not as wide variations in the

breaks and in the flours; the low grade, instead of containing less gluten, has more than the bakers' or patent. This may be due to the greater softness of the wheat, in consequence of which it is less suited to the process, a fact which is confirmed to a certain degree by the specimens of flour from Ohio wheat, among which the low grade, although not exceeding the other brands in the amount of gluten, approaches very nearly to them, and it is therefore only reasonable to conclude that the spring wheats are particularly suited for roller-milling.

RELATION OF NITROGEN TO PHOSPHORIC ACID.

The variations in the percentages of ash in the different parts of the grain and in the constituents of the ash of each part, as far as investigated, correspond closely with the results of Dempwolff.* Our results are at present incomplete. They, however, furnish the data for an examination of the relation of nitrogen to phosphoric acid.

Starting with a ratio of 2.8 in the whole grain, with every purification of the product the figure rises until it reaches the highest grade middlings and patent-flour; that is to say, as we approach the more perfect products there is a greater loss of phosphates than of nitrogen. The highest ratios are found in the patent flours and in the chop and middlings, which lead directly to this product. In the flours from the reduction of the different grades of middlings the change in the ratio is gradual and corresponds closely to the inverse change in the amount of phosphates in the ash. A high ratio denotes, therefore, a deficiency in phosphates, and this is the chief fault with the high-grade flours.

THE GERMS.

One of the characteristic features of the roller-milling process, as has been mentioned, is the removal of the germ of the grain, thus preventing its injuring the quality of the flour. Among the by-products of the Pillsbury mill are included three separations of germs known as first, second, and third. They are all rich in oil and albuminoids, which together form one-half of the substance. The second germ seems to be freer from contamination and was selected for a more detailed examination.

The following determinations were made:

Analysis of germ.

Constituents.	Per cent.	Per cent.
Water		8.75
Ash		5.45
Oil		15.61
Soluble in 80 per cent. alcohol	26.45	
Insoluble in water		1.98
Soluble in water	25.47	
Sugar or dextrine		18.85
Non-reducing substance		2.94
Albuminoids		3.65
Soluble in water	4.44	
Dextrine		1.44
Albuminoids		3.00
Starch, &c., undetermined		9.95
Fiber		1.75
Insoluble albuminoids		26.60
		100.00

* Liebig's Annalen der Chemie, cxlix, 345.

The interest of the analyses centers in the presence of so much sugar and soluble albuminoids. The sugar has been calculated to percentage as if it were dextrose. It does not reduce Fehling's solution until inverted by acids. It is dextro-rotatory, by inversion becoming less so, but not laevo-rotatory. It is uncertain whether it is formed from starch which may be present through the action of some ferment in the germ; but it seems probable, especially since so much soluble nitrogen is present pointing to diastatic action, and it may be classed somewhere between dextrine and maltose. In fact it has been found that the water extract if left in contact with the residue of the germ would soon be the cause of a peculiar fermentation. This shows the bad effect the presence of this soluble albuminoid would have in flour, causing a fermentation or putrefaction which would injure and discolor it. The oil in the germ is also an additional source of trouble, in that it is readily oxidized under certain circumstances and tends to blacken the flour.

THE RELATIONS OF THE WHEAT GRAIN AND ITS PRODUCTS TO THE HUMIDITY OF THE AIR.

In the report of W. H. Brewer on the cereals, in Vol. III of the Census for 1880, he gives the results of certain experiments by Hilgard, of California, showing the changes in weight of wheat when exposed to alternations of dry and moist air. California wheat, being particularly dry as it comes from the hot valleys where it grows, absorbs a large amount of moisture in the seaports or during transportation by sea. Brewer extended these experiments to all the cereals, and weighing them at intervals, found that under the conditions which he employed they without exception lost about the same amount from summer to winter that they would gain from winter to summer, and that when artificially dried and again exposed to the air, a few minutes would suffice for the absorption of several per cent. of moisture.

The importance commercially of this capacity for absorbing or losing moisture is of course apparent, and experiments were undertaken before the appearance of Brewer's report for a more thorough investigation of the subject, in reference especially to mill products.

The materials were exposed in the balance-room of the laboratory of the Department properly protected by a screen from exterior influences other than atmospheric. The condition of the atmosphere was noted by means of a psychrometer at the time of weighing.

The first series consisted of a number of flours from Minnesota, all milled by the roller process from hard spring wheats. Three of the five contained nearly 8 per cent. of water originally, one a little over 9, and one over 13. The first day of exposure was comparatively dry for the climate of Washington, but evidently moist as compared to the localities from which all the flours but one had come, because there was a large gain in the part of three, a small gain by the Pillsbury "A," and a loss by the only one holding originally a large amount of moisture; in fact, the result was an approximation to equalization of moisture in all, as would be expected. If we add the gains and subtract the losses, the figures, though not representing actual percentages, would appear for moisture as follows on the second day:

Number.	Original moisture.	Gain or loss.	Second day.
2114	9.48	+ .65	10.13
2115	7.80	+2.15	9.95
2116	7.85	+2.30	10.15
2117	7.97	+2.15	10.12
2120	13.69	—3.28	10.41

The first day's exposure was sufficient, therefore, to equalize the moisture in all the flours, and following them through the succeeding weeks, they all appear to be susceptible to the changes in condition of moisture in about the same degree.

A specimen of the whole grain exposed beside the flour proved itself not as susceptible as the finer material, but nevertheless responded to a certain degree to the daily changes in humidity. A tabulation of the results follow:

Experiments on the hygroscopic relations of flours.

Name of flours, &c.	Serial number.	Original per cent. of moisture.	March 8. Gain or loss.	March 8. Weight of original 100 lbs.	March 10. Gain or loss.	March 10. Weight of original 100 lbs.	March 11, 8 a.m. Gain or loss.	March 11, 8 a.m. Weight of original 100 lbs.	March 11, 3 p.m. Gain or loss.	March 11, 3 p.m. Weight of original 100 lbs.	March 12. Gain or loss.	March 12. Weight of original 100 lbs.	March 13. Gain or loss.	March 13. Weight of original 100 lbs.	March 14. Gain or loss.	March 14. Weight of original 100 lbs.
Dry bulb, °Fahr			73°		69°		62°		70°		68°		68°		69°.5	
Wet bulb, °Fahr			61°		55°		54°		61°.5		60°		54°		(?)	
Relative humidity, per cent			46.4		35.0		56.1		59.0		60.1		34.0			
FLOURS.																
Pillsbury "A," best	2114	9.48	+ .65	100.65	−1.12	99.53	+1.30	100.83	+ .90	101.73	+ .95	102.68	−2.80	99.88	+1.20	101.08
Patent Red River	2115	7.80	+2.15	102.15	− .73	101.42	+1.10	102.52	+1.00	103.53	+1.05	104.57	−2.60	101.97	+1.10	103.07
Patent Frazee, Minnesota	2116	7.85	+2.30	102.30	− .60	101.70	+1.10	102.80	+1.00	103.80	+1.15	101.95	−2.70	102.25	+1.00	103.25
Patent Pembina	2117	7.97	+2.15	102.15	− .60	101.55	+1.20	102.75	+ .85	103.60	+1.20	104.89	−2.75	102.05	+1.10	103.15
Patent Minnesota	2120	13.69	−3.28	96.72	−1.37	95.35	+1.20	96.55	+ .80	99.35	− .85	98.20	−2.70	95.50	+1.10	96.69
WHOLE WHEAT.																
Lamoure County, Dakota, spring	2111	9.57					+ .26	100.26	− .09	100.17	+1.25	101.42	− .92	100.50	− .08	100.42

NOTE.—In this table the figures in the second column of each date represent the weight which 100 lbs. of the original flour would have assumed under the conditions named.

Experiments of the hygroscopic relations of flours—Continued.

Name of flours, &c.	Serial number.	Original per cent. of moisture.	March 15.		March 17.		March 18.		March 19.		March 20.		March 21.		March 22.		March 24.	
			Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.
Dry bulb, °Fahr	......	......	70°	....	63°	....	67°	....	68°	....	71°5	....	69°	....	68°	....	67°5	....
Wet bulb, °Fahr	......	......	59°	....	32°	....	59°	....	60°	....	62°	....	59°	....	58°	....	61°	....
Relative humidity, per cent.	......	......	48.2	....	42.2	....	59.5	....	60.1	....	55.6	....	51.8	....	51.1	....	66.9	....
FLOURS.																		
Pillsbury "A," best	2114	9.48	+ .45	101.53	−1.15	100.38	+1.50	101.88	+ .15	102.03	+ .45	102.48	−1.05	101.43	+ .25	101.68	+1.20	102.88
Patent Red River	2115	7.80	+ .55	103.62	−1.35	102.27	+1.35	103.82	+ .15	103.97	+ .65	104.62	−1.20	103.42	+ .30	103.72	+1.15	104.87
Patent Frazee, Minnesota	2116	7.85	+ .50	103.75	−1.10	102.65	+1.50	104.15	+ .10	104.25	+ .60	104.85	−1.20	103.65	+ .30	103.95	+1.25	105.20
Patent Pembina	2117	7.97	+1.35	104.50	−1.00	103.50	+1.40	104.90	+ .17	105.07	+ .50	105.57	−1.12	104.45	+ .30	104.75	+1.20	105.95
Patent Minnesota	2120	13.69	+1.30	97.90	−1.00	96.90	+1.40	98.30	+ .13	98.43	+ .42	98.85	−1.00	97.85	+ .30	98.15	+1.20	99.35
WHOLE WHEAT.																		
Lamoure County, Dakota, spring	2111	9.57	+ .26	100.68	− .36	100.32	+ .75	101.07	+ .08	101.15	+ .34	101.49	− .30	101.19	− .08	101.11	+ .84	101.95

NOTE.—In this table the figures in the second column of each date represent the weight which 100 lbs. of the original flour would have assumed under the conditions named.

Flours of the same quality being so much alike in their faculty of absorbing moisture, the experiment was made of exposing different grades with the object of learning whether they would be independent in their action. The results in the table show that the starchy patent grade has a rather greater affinity for water than the others, and that the bakers' grade, which is the most glutinous, has the least.

Experiments on the hygroscopic relation of grades of flour.

Name.	Serial number.	Original per cent. of moisture.	March 15.		March 17, 10 a.m.		March 18, 10 a.m.		March 19, 10 a.m.		March 20, 10 a.m.		March 21, 10 a.m.		March 22, 10 a.m.		March 24, 10 a.m.		March 27, 10 a.m.		March 27, 1 p.m.	
			Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.
Dry bulb, °Fahr.			70°		63°		67°		68°		71°5											
Wet bulb, °Fahr.			59°		52°		59°		60°		62											
Relative humidity per cent.			48.2		42.2		59.5		60.1		53.6		Moist		Moist		Moist		Moist		Dry	
GRADES OF FLOUR.																						
Bakers'	2056	12.18	−.75	99.25	−1.60	97.65	+1.25	98.90	+.38	98.28	+.32	99.60	+6.25	105.85	+.35	106.20	+1.12	107.32	+.40	107.72	−7.35	100.37
Patent	2057	11.48	+.95	100.95	−1.05	99.90	+1.40	101.30	+.45	101.75	+.40	102.15	+5.55	107.[illegible]0	+.50	108.20	+1.30	109.50	+.30	109.80	−6.18	103.62
Low grade	2058	12.01	−.62	99.38	−1.37	98.01	+1.40	99.41	+.35	99.76	+.30	100.06	+7.10	107.16	+.40	107.56	+1.70	109.26	+.40	109.66	−7.80	101.86

The approximate agreement between the different grades of flour under ordinary conditions being apparent, they were submitted to an atmosphere nearly saturated with moisture; that is to say, they were placed under a bell with a dish of water. They all gained from 7 to 9 per cent. over their air-dry weight, but the low grade and patent flour possessed the largest capacity for moisture, the bakers' holding about 2 per cent. less. On removal to dry air this gain was lost in a very few hours, the bakers' losing a proportionately larger amount than the others. Whether it is owing to a larger percentage in gluten in this flour that it gains less and loses more water than others is questionable.

A Minnesota patent exposed in a small desiccator to air saturated with moisture absorbed more than 26 per cent. of its original weight in sixty-four hours, and in one hundred and eight hours, or four days, more than 29 per cent.; but at that time a film of mould covered the flour. The determinations at intervals showed the gain to be—

	Grams.
Weight of flour taken	1.0000
Weight after 35 minutes	1.0285
Weight after 18 hours	1.0930
Weight after 22 hours	1.2005
Weight after 42 hours	1.2405
Weight after 64 hours	1.2670
Weight after 92 hours	1.2915

The flours are plainly more susceptible to moisture than the grain, owing to their greater comminution. It was found in California that the latter, after being artificially dried, would absorb 25 per cent. of moisture. Here a flour, although not dried, has absorbed over 29 per cent. of its original weight.

To decide what parts of the grain were able to absorb and retain the most moisture, how far the degree of comminution affected the result, several of the most prominent products of the roller process were treated in the same way as the previous specimens.

Experiments on the hygroscopic relations of mill products.

Products, &c.	Serial number.	Original per cent. of moisture.	April 1.		April 2.		April 3.		April 5.		April 7.		April 10.		April 12.		April 14.	
			Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.
Dry bulb ° Fahr.	......	68°	68°	....	70°.5	....	72°	....	69°	....	70°	....	70°	....	69°	....	68°	....
Wet bulb ° Fahr.	......	55°	56°	....	60°	....	58°	....	55°	....	57°	....	58°	....	56°.5	....	60°	....
Relative humidity (per cent.)	......	38.1	42.4	....	50.7	....	37.8	....	35.0	....	40.0	....	44.1	....	41.1	....	69.1	....
MILL PRODUCTS.																		
Entire wheat (80 mesh)	2002	9.07	—.30	99.70	+.50	100.20	—1.00	99.20	—.16	99.04	+.57	99.61	—.05	99.56	—1.05	98.51	+2.83	101.34
Bran (80 mesh)	2017	10.91	+.47	100.47	+2.20	102.67	—.90	101.77	—.15	101.62	+.57	102.19	+.02	102.21	—.11	102.10	+2.17	104.27
Shorts (80 mesh)	2078	10.94	+.03	100.03	+1.05	101.08	—.95	100.13	—.15	99.98	+.62	100.60	—.03	100.57	—.11	100.46	+2.00	102.46
Third germ (80 mesh)	2072	7.68	—.28	99.72	+.90	100.62	—1.30	99.32	—.10	99.22	+.55	99.77	+.08	99.85	—.16	99.69	+2.46	102.15
Patent flour	2114	9.48	—.05	99.95	+1.15	101.10	—1.20	99.90	—.15	99.75	+.63	100.38	+1.17	101.55	—.17	101.38	+1.94	103.32
Bran (coarse)	2017	10.91	—.60	99.40	+.45	99.85	—1.25	98.60	—.15	98.45	+.42	98.87	+.18	99.05	—.15	98.90	+1.78	100.68
Fifth middlings	2028	12.18	—.85	99.15	+.30	99.45	—1.30	98.15	—.20	97.95	+.38	98.33	+.17	98.50	+.17	98.33	+1.79	100.12

Experiments on the hygroscopic relations of mill products—Continued.

Products, &c.	Serial number.	Original per cent. of moisture.	May 7.		May 12.		May 13.		May 14.		May 15.		May 19.		May 21.		May 23.	
			Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.	Gain or loss.	Weight of original 100 lbs.
Dry bulb °Fahr	......	68°	70°.5	....	70°	....	70°	....	72°	....	72°	....	74°	....	75°	....	77°.5	....
Wet bulb °Fahr	......	55°	62°.5	....	56°	....	59°.5	....	59°.5	....	58°	....	65°	....	64°.5	....	71°	....
Relative humidity (per cent.)	......	38.1	61.5	....	35.9	....	50.3	....	43.7	....	3.78	....	59.3	....	53.7	....	71.2	....
MILL PRODUCTS.																		
Entire wheat (80 mesh)	2002	9.07	+1.65	102.99	−2.45	100.54	+.65	101.19	+.01	101.20	−.44	100.76	+2.06	102.82	−.73	102.09	+1.05	101.05
Bran (80 mesh)	2017	10.91	+1.60	105.87	−2.47	103.40	+.72	104.12	−.01	104.11	−.50	103.61	+2.26	105.87	−.95	104.92	+1.40	101.40
Shorts (80 mesh)	2078	10.94	+1.37	103.83	−2.45	101.38	+.70	102.08	+.15	102.23	−.60	101.63	+2.25	103.88	−.93	102.95	+1.33	101.33
Third germ (80 mesh)	2072	7.68	+1.82	102.97	−2.90	100.07	+.95	101.02	+.11	101.13	−.69	100.44	+3.33	103.77	−1.65	102.12	+2.20	102.20
Patent flour	2114	9.48	+1.31	104.63	−2.50	102.13	+.72	102.85	+.02	102.87	−.62	102.25	+2.14	104.39	−.73	103.66	+1.01	101.01
Bran (coarse)	2017	10.91	+1.02	101.70	−2.50	99.20	+.77	99.97	+.07	100.04	−.61	99.43	+2.17	101.60	−.75	100.85	+1.35	101.35
Fifth middlings	2028	12.18	+1.08	101.20	−2.43	98.77	+.68	99.45	+.20	99.65	−.80	98.85	+2.06	100.91	−.60	100.31	+.94	100.94

Experiments on the hygroscopic relations of mill products—Continued.

Products, &c.	Serial number.	Original per cent. of moisture.	May 24. Gain or loss.	May 24. Weight of original 100 lbs.	May 28. Gain or loss.	May 28. Weight of original 100 lbs.	May 29. Gain or loss.	May 29. Weight of original 100 lbs.	June 5. Gain or loss.	June 5. Weight of original 100 lbs.	June 7. Gain or loss.	June 7. Weight of original 100 lbs.	June 10. Gain or loss.	June 10. Weight of original 100 lbs.	June 12. Gain or loss.	June 12. Weight of original 100 lbs.	June 27. Gain or loss.	June 27. Weight of original 100 lbs.
Dry bulb °Fahr	......	68°	78°5	....	74°5	....	68°	....	80°	....	75°	....	77°5	....	75°	....	73°	....
Wet bulb °Fahr	......	55°	73°	....	67°5	....	54°5	....	65°	....	69°	....	71°5	....	71°	....	61°	....
Relative humidity (pr. ct.)	......	38.1	75.7	....	67.9	....	36.0	....	40.7	....	72.4	....	78.3	....	81.2	....	46.4	....
MILL PRODUCTS.																		
Entire wheat (80 mesh)	2002	9.07	+1.47	102.52	−1.12	101.40	−3.40	98.00	+1.52	99.52	+2.68	102.12	+ .90	103.02	+ .45	103.47	−3.77	99.70
Bran (80 mesh)	2017	10.91	+2.00	103.40	−1.80	101.60	−3.48	98.12	+1.48	99.60	+3.30	102.90	+1.28	104.18	+ .37	104.55	−4.95	99.60
Shorts (80 mesh)	2078	10.94	+1.77	103.10	−1.49	101.63	−3.61	98.02	+1.41	99.43	+3.32	102.75	+1.18	103.93	+ .40	104.33	−4.88	99.45
Third germ (80 mesh)	2072	7.68	+2.90	105.10	−2.95	102.15	−4.56	99.59	+1.47	99.06	+5.19	104.25	+1.65	105.90	+ .25	106.15	−7.20	98.95
Patent flour	2114	9.48	+1.22	102.23	−0.90	101.33	−3.40	97.93	+1.60	99.53	+2.30	101.83	+ .75	102.58	+ .33	102.91	−3.28	99.63
Bran (coarse)	2017	10.91	+1.76	103.11	−1.56	101.61	−3.47	98.14	+1.45	99.59	+3.10	102.69	+1.17	103.86	+ .35	104.21	−4.73	99.48
Fifth middlings	2028	12.18	+1.20	102.14	− .90	101.24	−3.22	98.02	+1.52	99.52	+2.30	101.84	+ .75	102.59	+ .30	102.89	−3.35	99.54

The coarser products absorbed less moisture than the finer, at least where there was a marked change, and among the fine material there was less difference than might be expected. The germ after more than two months' exposure seemed to have accumulated more water than any other, but a rather dry atmosphere, with the thermometer at 73° F. on the 27th of June, brought the whole series below their original degree of moisture. A fresh portion of the germ exposed for a few days for comparison with that which had been weighed out longer rapidly reached a point even in excess of the latter, it being fresher and not caked so much together. The gains and losses were as follows:

No. 2072.

May 24, 1.30 p. m	102.88
May 24, 2.30 p. m	103.18
May 26, 10 a. m	103.93
May 28, 10 a. m	104.83
May 29, 10 a. m	99.28
June 5, 10 a. m	100.83
June 9, 10 a. m	106.13
June 10, 10 a. m	107.69

and then left in the balance case with a dish of sulphuric acid for forty-eight hours:

June 12	104.05

and over chloride of calcium in a desiccator forty-eight hours:

June 14	96.38

or nearly dry.

The results are instructive, and show how susceptible all portions of the wheat grain, in whatever state of comminution, are to hygroscopic conditions; and it will be noticed, as was found by Brewer, that in summer the amount of moisture held by grain is larger than in winter.

FLOURS.

The analyses of flours given in a previous bulletin having proved unsatisfactory to the millers of the Northwest, they furnished the Department with a series of selected samples of the best Minnesota and Dakota "patents." These, together with an Ohio and a District of Columbia "patent flour" obtained directly from the millers, have been analyzed.

American flours of 1883.

Constituents.	1856.	2100.	2057.	2114.	2115.	2116.	2117.	2118.	2119.	2121.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Water	12.32	12.98	11.48	9.48	7.80	7.85	7.97	7.64	8.11	11.33
Ash	.34	.32	.39	.39	.42	.42	.45	.42	.52	.91
P_2O_5	.18	.16	.21	.26	.27	.23	.23	.26	.32	.48
Nitrogen	1.71	1.60	2.07	1.99	2.02	1.99	1.88	2.13	2.16	2.18
Albuminoids	10.68	9.98	12.95	12.43	12.60	12.43	11.73	13.30	13.48	13.65
Moist gluten	35.52	29.55	....	36.14	41.05	40.82	35.20	36.60	44.85	36.73
Dry gluten	10.76	9.08	....	10.85	11.74	11.81	10.58	11.11	12.59	12.03

1856. Patent flour, Warder & Barnett, Springfield, Ohio.
2100. Patent flour, Herr & Cissel, Georgetown, D. C.
2057. Patent flour, C. L. Pillsbury, Minneapolis, Minn.
2114. Patent flour, Pillsbury "A," best, Minneapolis, Minn.
2115. Patent flour, Red River Roller Mills, Fergus Falls, Minn.
2116. Patent flour, R. L. Frazee, Frazee City, Minn.,
2117. Snow Cloud, Pembina Mill Company, Pembina, Dak.
2118. Fargo's Best, Fargo Roller Mills, Fargo, Dak.
2119. No. 1 Straight, Fargo Roller Mills, Fargo, Dak.
2121. Patent Flour, George Davis, Ottawa, Minn.

The Eastern flour is poorer in nitrogen and gluten than any of the others. In fact the flours follow closely the composition of the wheat which has been examined from the same parts of the country. Dakota makes a flour richer than any other in gluten in the same way that it produces a wheat of that description. The sample from Pembina, like the wheat from that locality, is lower than any other spring-wheat flour. The average of these "Northwestern spring-wheat flours" is high, and in comparison with the rest of the country they are the richest which have been analyzed. They compare favorably with Hungarian roll flour, which they closely resemble.

Average composition of flours.

Constituents.	Eighteen for baking experiments.	Forty-nine flours, U. S. Census.	Eight Eastern flours.	Minnesota and Dakota flours.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Water	12.35	11.56	12.40	8.96
Ash		.59	.55	.44
Albuminoids	11.03	11.90	10.41	12.82

Another peculiarity of the spring-wheat flours is their dryness. It will be seen in the averages that they contain several per cent. less moisture than the Eastern specimens. From the results of the experiments on the relations of such material to atmospheric conditions it is plain that they would gain weight on transportation east or to the coast, and other things being equal, a barrel of dry Western flour would make more bread than a barrel of Eastern. This is certainly an important factor in the consideration of the value of flours. In specimens Nos. 2057 and 2121 the absorption had, to a large extent, taken place, while the others, being tightly boxed, were received without any absorption. How readily this would have taken place had an opportunity occurred, will be seen in the analyses of the flours used for baking.

In the light of the preceding analyses there seems to be no reason to doubt but that the introduction of the roller milling process and the growth of the hard wheats of the Northwest has furnished the country with a finer flour than it has before possessed, and one which should make a bread comparing favorably with Hungarian manufacture. In fact in the baking experiments the bread made from these flours excelled all others in quality.

The flours which have just been mentioned as used for experimental baking purposes have been so far examined as to determine the percentages of water, nitrogen, and albuminoids, and moist and dry gluten. The results are here collected:

Analyses of flours used in baking.

Variety.	Serial number.	Water.	Nitrogen.	Albumen.	Gluten.	
					Moist.	Dry.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Maryland patent	2593	11.55	1.65	10.33	33.32	9.60
Maryland straight	2800	11.08	1.75	10.94	32.49	10.28
Maryland low-grade	2808	12.78	1.84	11.50	30.15	11.13
District Columbia patent	2821	12.98	1.46	9.10	31.58	9.09
District Columbia straight	2820	12.38	1.53	9.56	33.40	9.76
Virginia straight	2591	12.16	1.93	12.08	36.07	11.41
Virginia low-grade	2807	11.77	2.02	12.60	36.81	11.60
Virginia patent	2805	12.10	1.73	10.81	37.89	11.08
Ohio patent	2190	12.85	1.70	10.62	29.63	10.47
Indiana patent	2822	12.33	1.59	9.94	33.60	10.03
Illinois patent	2594	12.00	1.93	12.08	37.36	11.56
Wisconsin straight	2801	12.37	1.60	9.98	28.39	9.56
Wisconsin patent	2806	13.25	1.85	11.55	34.45	10.65
Minnesota patent	2592	12.82	1.90	11.90	39.18	11.98
Minnesota low-grade	2599	12.05	2.51	15.64	34.22	14.06
Minnesota bakers'	2803	11.77	1.95	12.19	36.71	11.71
Missouri patent	2804	12.04	1.67	10.44	32.24	9.23
Oregon new process	2824	14.03	1.15	7.18	20.84	6.75

They are remarkably uniform in albuminoids and gluten; and also in moisture, showing that they had, with the exception of the Oregon flour, been subjected to very similar hygroscopic conditions. The flours from Minnesota have, without doubt, gained moisture since they were originally milled, if it is possible to judge from previous analyses of samples sent directly from the mills. For this reason, in our bread experiments with this collection of flours, less variation in yield was found than if they had been used directly from the mill with wider variations in their per cent. of moisture.

Among them all two present peculiarities worthy of notice. The Oregon new-process flour contains 7.18 per cent. of albuminoids, the smallest amount yet found in the course of analysis. In this respect it corresponds to Oregon wheat, and confirms the remarks thereon on a previous page. On the other hand, the Minnesota low-grade contains more albuminoids and gluten than any heretofore examined. This would not only be remarkable for any flour, but is still more so for one of low grade. How it was graded is unknown. It makes a very dark bread.

BAKING EXPERIMENTS WITH FLOURS FROM VARIOUS SOURCES.

The experiments of the McDougall Brothers, London, in the autumn of 1882, upon the baking qualities of flour made from wheats in the English market from different parts of the world, have had a wide circulation. The Statistician of this Department in his report upon the condition of crops for December, 1883, mentions and quotes them as follows:

EXPERIMENTS IN BREAD-MAKING.

In the autumn of 1882 the secretary of State of India arranged with McDougall Brothers, millers and bakers, London, to conduct a series of experiments with wheats from

India in comparison with average samples of wheat from the principal countries producing this grain. Of the conditions required by the secretary they say:

"1. That we should take a given quantity of each of these four representative Indian wheats, viz., Indian fine soft white, Indian superior soft red, Indian average hard white, Indian average hard red, and manufacture them into flour by the ordinary process of grinding under millstones. Also that we should take similar quantities of the same wheats and manufacture them into flour by means of crushing between rollers, according to the system known as the Hungarian or roller system. 2. That we should take a given quantity of each flour so produced and manufacture it into bread. 3. That we should note the qualities and other characteristics of the flours produced, also of the offals, viz., middlings, pollard, and bran. 4. That we should procure the following representative wheats, of fair average quality of the season, as then being sold on Mark Lane market, and, for the purpose of obtaining results for comparison, deal with them precisely as above indicated, both as regards flour, bread, and offals, viz., English average, American red winter, American spring, Australian average, California average, Russian Saxonska, Russian Taganrog, Russian Kubanka, Russian Ghirka, Egyptian Buhi, and Egyptian Saida."

The quantity used in each case was 5,000 pounds. The samples varied in weight from 57½ pounds for the Saida Egyptian to 64 pounds for the soft Indian white variety. The weight of the separate "berries" varied greatly; those of American spring were smallest of all, 100 weighing 35.5 grains; winter, 49.6 grains; California, 47.7 grains. The Australian were heaviest, 80.5 grains; Indian, from 51.8 to 77.7 grains. The Saxonska Russian was 37.3 grains, next to American spring the smallest, and containing the most gluten, 23.2 per cent.; yet the size appears to be no indication of the proportion of gluten in other samples, as the heaviest, the Australian, averaged 11.6 per cent., and the poorest in gluten, bearing only 4.4 per cent., was of medium weight, 50.1 for 100.

Wheat.	Value in London per 496 pounds. Net weight on day of valuation.	Weight per bushel.	Impurities removed.	Water absorbed to render mellow.	Yield.				Evaporation and loss.	Gluten by water tests.
					Flour.	Middlings.	Pollard.	Bran.		
	S. d.	Lbs.	Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.
Indian (fine soft white)	49 0	64	1.52	2.0	77.46	0.82	8.8	12.0	1.40	6.4
Do	49 0	64	1.52	2.0	74.10	11.00	8.7	4.0	2.68	6.8
Indian (superior soft red)	45 0	62¾	.72	3.6	78.40	1.68	9.8	9.4	3.6	9.3
Do	45 0	62¾	.72	3.6	75.4	7.7	13.5	5.3	.98	10.5
Indian (average hard white)	44 0	60	3.7	8.4	80.52	.78	10.0	8.3	5.1	11.7
Do	44 0	60	3.7	8.4	73.2	10.3	14.3	3.1	3.8	12.6
Indian (average hard red)	43 0	61½	1.2	7.6	79.88	.78	13.20	8.5	4.04	13.4
Do	43 0	61½	1.2	7.6	74.2	10.3	13.8	3.0	5.1	13.1
English	49 0	60½	1.5	None.	65.2	1.1	9.7	17.7	4.8	10.6
Do	49 0	60½	1.5	None.	70.3	7.6	7.2	9.2	4.2	11.4
Australian	50 6	62½	1.0	None.	75.8	1.1	7.4	14.4	.3	11.6
Do	50 6	62½	1.0	None.	75.1	8.0	9.3	5.5	1.1	12.2
New Zealand	48 0	62¾	.3	None.	76.1	.96	8.8	11.5	2.34	10.2
Do	48 0	62¾	.3	None.	76.1	7.8	6.6	5.6	3.6	9.0
California	48 0	59¼	1.7	None.	71.1	.72	9.2	15.3	1.98	10.5
Do	48 0	59¼	1.7	None.	70.1	14.5	6.3	3.9	3.5	8.7
American (winter)	49 6	61¾	.5	None.	73.8	.38	7.9	16.4	1.02	11.0
Do	49 6	61¾	.5	None.	71.5	10.3	11.2	3.1	3.4	11.7
American (spring)	48 0	61	.9	None.	72.2	.24	7.2	14.7	4.76	15.3
Do	48 0	61	.9	None.	69.5	12.1	10.4	3.8	3.3	14.6
Russian (Saxonska)	52 0	60½	.9	None.	73.0	1.2	11.6	12.6	.7	22.1
Do	52 0	60½	.9	None.	71.4	12.5	11.7	3.3	.2	23.2
Russian (hard Taganrog)	49 0	61½	.8	2.4	76.2	1.2	12.7	8.1	3.4	17.6
Do	49 0	61½	.8	2.4	72.0	9.6	12.1	5.0	2.9	15.6
Egyptian (Buhi)	47 0	58	2.7	3.1	72.9	1.0	11.0	10.0	5.5	4.4
Do	47 0	58	2.7	3.1	72.6	10.4	8.5	3.5	5.4	7.9
Egyptian (Saida)	43 6	57½	12.1	2.7	66.9	.76	11.4	7.5	4.04	7.5
Do	43 6	57½	12.1	2.7	67.8	7.2	6.5	4.9	4.2	6.6

It will be seen that there were fewest impurities in the New Zealand, Indian soft red, American, and Russian samples.

The manufacture of bread from Indian wheats by the millstone and also the roller process, and from other samples by the roller method, was next undertaken. The

quantities used in each case were 280 pounds of flour, 30 pounds of liquid potato ferment, one pound of French yeast, and 3½ pounds of salt. The table is as follows:

Wheat.	Water used.	Yield of bread when cold.	Percentages.		Color, taste, and texture.				
			Percentage of bread to flour.	Percentage of water to flour.	Color, exterior.	Color, interior.	Flavor.	Texture.	General characteristics.
	Pounds.	*Pounds.*							
Indian (fine soft white)	141.4	364.0	130.0	50.5	10	11	7	8	11
Do	149.6	367.5	131.2	53.4	13	13	9	9	12
Indian (superfine soft white)	141.6	372.0	133.0	50.6	8	10	7	9	10
Do	148.0	362.0	129.3	52.3	12	13	9	10	11
Indian (average hard white)	141.0	370.5	132.4	50.8	6	7	7	10	7
Do	149.6	365.0	130.3	53.4	10	9	9	10	9
Indian (average hard red)	145.2	376.6	134.5	51.8	5	7	7	10	6
Do	147.4	365.0	130.3	52.2	9	9	8	10	8
English	130.0	352.0	125.7	46.4	13	12	13	10	10
Australian	134.2	355.4	126.9	48.0	12	12	12	10	11
New Zealand	132.0	349.0	124.6	47.1	12	12	12	9	10
California	136.8	364.0	130.0	48.9	12	12	12	9	10
American:									
Winter	130.0	346.0	123.5	46.4	13	12	12	10	11
Spring	130.0	354.0	126.4	46.4	8	10	10	12	9
Russian:									
Saxonska	130.0	356.0	127.1	46.4	8	9	9	13	9
Hard Taganrog	145.4	354.5	126.6	51.9	10	11	9	12	9
Egyptian:									
Buhi	136.8	362.0	129.3	48.9	7	6	6	7	5
Saida	144.4	558.0	127.7	51.6	6	4	4	6	4

Whether the Indian wheats were average samples of the product of that country, or a little better through the unconscious partiality of the secretary, may be questionable. They make a good showing for quantity of product, but the *quality* of the soft wheats is quite inferior to that of samples from this country. In the United States California appears to take the lead in quantity of bread, while the spring wheats of the Northwest not only surpass other American samples in quality, but are unequaled in that respect by any wheats included in this experiment, the Russian only excepted, which excel in gluten.

The following statement relative to the effect of dryness of the grain upon the yield of bread is extracted from this report:

"It is generally believed that upon the percentage of gluten in flour depends the *yield* of bread that may be obtained from it, as illustrated by the Hungarian flours, which are almost unequaled for yield of bread, and rank high in gluten; but this is erroneous, as proved by the experimental workings now under review. It would be found that the flours high in gluten do not produce the most bread, unless, at the same time, they possess a high degree of *dryness*, for it is upon the dryness of the flour that the yield of bread mainly depends, and not upon the gluten. The two lots of flour from Russian wheats (Nos. 11 and 12) are those which are highest in gluten, yet they do not yield as much bread as any of the four Indian wheats (Nos. 1 to 4), and the difference in yield from the latter would have been still further increased had they not been previously mellowed with water, as noted, before milling; confirming that it is the dryness of a flour that determines the yield of bread."

There being considerable doubt as to whether the samples of American wheats in the preceding experiments were representative, a series of baking experiments with flours of various grades from different parts of this country have been carried on in our laboratory with the results which are presented.

The McDougall Brothers found, and it has been confirmed by us, that upon the dryness of a flour, or upon the amount of water which it is possible to add to the dough, depends chiefly the amount of bread which it will yield. Unfortunately no determination of the amount of moisture in the flours used was made in the English tests.

In our experiments, using the same flour under various conditions, it was found possible to vary the yield of bread per 100 pounds of flour as

much as 15 pounds. The conditions upon which this variation depends are largely physical, and include—

Percentage of water used in the dough.

Size of the loaves.

Temperature of the oven.

Time of baking.

Of course in any series of comparative experiments these conditions must be closely observed and regulated. In order to learn the best modifications for our work, a preliminary series was undertaken with a flour from Ohio.

In the beginning it was found that a dough made with any of our flours and as small a percentage of water as was used by the McDougalls would be altogether too stiff for successful results.

In the English experiments with flours from American wheat 46.4 per cent. of water was used, but in our experience it has been found necessary to add on the average about 56 per cent. of water, or water and milk. The result has been that we have obtained a much larger yield of bread per hundred pounds.

The effects of variation in physical conditions are illustrated by the following data:

Variation in yield dependent on percentage of water used (other conditions being the same), on size of loaves, on difference of temperature, and on time of baking.

[Ohio patent flour.]

Dependent on percentage of water used (other conditions being the same).		Dependent on size of loaves.		Dependent on difference of temperature.		Dependent on time of baking.	
Per cent. of water.	Yield of bread.	No. of loaves.	Yield of bread.	Temperature.	Yield of bread.	Minutes.	Yield of bread.
				°			
54.5	134.5	1 loaf.	138.6	249	136.9	50	134.6
58.4	136.9	10 rolls.	129.6	230	140.8	30	140.2
62.1	144.9						
62.1	145.5						

In all these cases the yield is largely modified by the change in a single condition, the remaining ones being constant. It is evident, therefore, how complicated a comparative series of experiments becomes when all the above conditions exercise their modifying effects and must therefore be kept constant.

There are also conditions of mixing and raising which in a like manner affect the yield. As every one knows, there are different methods of carrying out these operations, and larger or smaller amounts of yeast may be used. The method which we have finally employed is a modification of the Vienna procedure as described by Horsford. The dough is mixed in mass with press yeast and allowed to rise till the outer pellicle is just cracking. It is then rekneaded into loaves, put in pans, and set in a warm place until the dough is again risen, when it is baked.

The baking was carried on in a large gas-stove, the oven of which by means of a thermometer could be kept at a very regular temperature. All the materials used and the products obtained were weighed to 1 gramme (15 grains), so that the results as far as manipulation go may be regarded as accurate.

Having fixed these conditions, as they appear in the table which follows, the experiments were conducted with the different flours which have been collected.

Results of baking experiments.

Name of flour.	Serial number.	Experiment number.	Weight of flour.	Weight of milk.	Weight of water.	Weight of salt.	Weight of yeast.	Relation of water to flour.	Raised.	Loss in rising.	Raised in pans.	Baked.	Temperature of oven.	Bread.				Moisture.	Nitrogen.	Albumen.	Gluten.	
														Weight, hot.	Per cent. hot.	Weight, cold.	Per cent. cold.				Moist.	Dry.
									° ′		° ′	′	° C.					Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
Maryland Patent Flour	2593	18	2,032	500	650	25	10	56.59	2 35	12	1 07	45	......	2,856	140.6	2,720	134.4	11.55	1.65	10.33	33.32	9.60
		31	2,049	500	650	25	10	56.12	3 00	30	1 00	45	228	2,933	143.2	2,795	136.4					
Maryland Straight	2800	21	2,014	500	650	25	10	57.09	2 56	28	1 06	45	......	2,937	145.8	2,754	136.7	11.08	1.75	10.94	32.49	10.28
		34	2,031	500	650	25	10	56.62	2 45	23	1 00	50	248	2,866	141.1	2,746	135.2					
Maryland Low Grade	2808	24	2,024	500	650	25	10	56.82	2 35	18	55	45	243	2,846	140.6	2,740	135.4	12.78	1.84	11.50	30.15	11.13
		37	2,024	500	650	25	10	56.82	2 45	32	1 00	55	243	2,859	141.3	2,759	136.3					
District of Columbia Patent	2821	43	2,073	500	650	25	10	55.48	2 30	59	1 00	45	236	2,873	138.6	2,764	132.9	12.98	1.46	9.10	31.58	9.00
		47	2,056	590	650	25	10	55.93	3 00	36	1 00	45	230	2,833	137.8	2,732	132.9					
District of Columbia Straight	2820	42	2,045	500	660	25	10	56.23	2 30	38	1 00	45	245	2,867	140.2	2,757	134.8	12.38	1.53	9.56	33.40	9.76
		46	2,030	500	650	25	10	56.65	2 30	31	1 00	45	235	2,830	139.4	2,730	134.5					
Straight Virginia	2591	14	2,033	500	650	25	10	56.57	2 35	12	55	30	......	2,948	145.0	......	......	12.16	1.93	12.08	36.07	11.41
		16	2,044	500	650	25	10	56.26	2 41	19	1 02	45	......	2,886	141.2	2,792	136.6					
		29	2,025	500	650	25	10	56.79	2 45	21	1 00	45	248	2,931	144.7	2,808	138.7					
Low Grade Virginia	2807	23	2,032	500	650	25	10	56.59	2 57	17	1 15	45	247	2,898	142.6	2,785	137.1	11.77	2.02	12.60	36.81	11.60
		36	2,038	500	650	25	10	56.43	2 40	28	1 00	45	248	2,870	140 8	2,738	134.3					
Roller Patent, Virginia	2805	28	2,034	500	650	25	10	56.54	2 35	11	1 07	45	248	2,838	139.5	2,733	134.4	12.10	1.73	10.81	37.89	11.08
		41	2,047	500	650	25	10	56.19	2 55	34	1 00	45	230	2,914	142.4	2,781	135.9					
Ohio Patent	2190	11	2,149	500	650	25	10	53.51	3 16	32	1 15	48	......	2,986	138.8	......	......	12.85	1.70	10.62	29.63	10.47
		12	2,110	500	650	25	10	54.50	......	24	......	50	......	2,989	141.7	2,840	134.6					
Indiana Patent	2822	44	2,049	500	650	25	10	56.12	2 35	31	1 35	45	240	2,908	141.4	2,780	135.7	12.33	1.59	9.94	33.60	10 03
		48	2,068	500	650	25	10	55.61	2 50	35	1 00	50	230	2,898	140.1	2,772	134.0					
Illinois Patent Flour	2594	19	2,041	500	650	25	10	56.35	2 35	4	55	45	......	2,914	142.8	2,791	136.8	12.00	1.93	12.08	37.36	11.56
		32	2,043	500	650	25	10	56.29	2 47	19	1 00	45	232	2,862	140.1	2,754	134.8					
Wisconsin Straight	2801	22	2,035	500	650	25	10	56.51	2 50	28	55	45	......	2,832	139.2	2,730	134.2	12.37	1.60	9.98	28.39	9.56
		35	2,031	500	650	25	10	56.62	2 30	29	1 00	45	245	2,852	140.4	2,728	134.3					
Roller Patent, Wisconsin	2806	27	2,034	500	650	25	10	56.54	2 52	13	1 00	45	249	2,900	142.6	2,788	137.1	13.25	1.85	11.55	34.45	10.65
		40	2,040	500	650	25	10	56.37	2 30	33	1 00	45	234	2,862	140.3	2,745	134.1					
Best Minnesota Patent Process	2592	15	2,033	500	650	25	10	56.57	2 35	28	55	30	......	2,951	145.2	......	......	12.82	1.90	11.90	39.18	11.98
		17	2,028	500	650	25	10	56.71	2 43	18	57	45	......	2,825	139.3	2,747	135.5					
		30	2,024	500	650	25	10	56.82	2 30	23	1 00	45	242	2,802	138.4	2,784	137.6					
Minnesota Low Grade	2599	20	2,006	500	650	25	10	57.33	2 37	13	1 00	45	......	2,915	145.3	2,807	139.9	12.05	2.51	15.69	34.22	14.06
		33	2,029	500	650	25	10	56.68	3 05	26	1 00	45	234	2,886	142.2	2,786	137.3					
Minnesota Bakers'	2803	26	2,024	500	650	25	10	56.82	2 35	21	1 00	45	246	2,885	142.5	2,742	135.5	11.77	1.95	12.19	36.71	11.71
		39	2,031	500	650	25	10	56.62	2 40	32	1 00	45	238	2,928	144.2	2,803	138.0					
Roller Patent, Missouri	2804	25	2,059	500	650	25	10	55.85	2 43	31	1 00	50	248	2,816	138.2	2,738	133.0	12.04	1.67	10.44	32.24	9.23
		38	2,042	500	650	25	10	56.32	2 45	39	1 00	45	242	2,859	140.1	2,746	134.5					
New Process Oregon	2824	45	2,085	500	650	25	10	55.16	2 40	41	1 00	45	240	2,873	137.8	2,689	129.0	14.03	1.15	7.18	20.84	6.75
		49	2,087	500	650	25	10	55.10	2 30	24	1 05	45	240	2,883	138.1	2,753	132.0					

The results are variable within limits which are so narrow as to make it impossible to say that one flour will make much more bread than another, and it will be observed that the lowest grade gives as large a yield, or even larger, than the best patent. If, however, the moisture in the flour had been less uniform, our results would probably show a larger yield of bread for the drier flours. The conclusion must be then that the yield is dependent on physical conditions of bread-making, and not to a large extent upon the chemical composition of the wheat. In all our experiments we get a much larger percentage of bread than the McDougalls, but it is due to the possibility of the use of larger amounts of water in the dough. In other respects their conclusions are confirmed that water is the chief conditioning agent, and that the per cent. of gluten has but little effect upon the yield.

That it has some, however, appears from the fact that the largest yield was obtained with a Minnesota low-grade flour, having the highest gluten of any experimented with, and the lowest yield was from the Oregon flour, having the smallest amount. The bread from the low-grade flour mentioned, although the heaviest yield, was dark and of the worst quality; that from the Oregon flour was white and fair. These flours are very peculiar, and in another place a few remarks are made upon their composition.

Aside from quantity the quality of the bread made from Minnesota patent flours is certainly as near perfect as could be wished. That from other patent flours suffers slightly in comparison, while, of course, the bread from straight flours, bakers', and low grade, cannot compare with that from patents.

NOTE ON THE CHEMICAL ALTERATIONS IN GREEN FODDER DURING ITS CONVERSION INTO ENSILAGE.

In recent numbers of the Journal of the Chemical Society, Prof. Edward Kinch and Dr. O. Kellner have published some observations upon the changes which take place in the silo, especially in the nitrogenous constituents of fodder. Analyses which have been made in this laboratory during the past two years throw additional light upon the subject, and are, although somewhat incomplete, presented here.

Professor Kinch found in the ensilage of grass that of the total nitrogen present, 55 per cent. was of a non-albuminoid nature, while in the original grass only 9 per cent. was in this form. Kellner found in the case of mangold leaves 27.8 per cent. in the original leaves and 45.5 per cent. in the ensilage, while in the ensilage preserved in stoppered jars, the proportion was even 59.7 per cent. of non-albuminoid nitrogen. In the ensilage of maize we have found—

Per cent. of total nitrogen as non-albuminoid.	Per cent.
Original stalks	21.2
Ensilage, No. 1	44.6
Ensilage, No. 2	49.6
Dried fodder	15.6
Ensilage from young maize	53.3
Ensilage from old maize	47.1

The three results with grass, mangold, and maize show that in the conditions existing in silos a large portion of the albuminoids are converted into non-albuminoid nitrogenous substances, while in the ordinary drying of fodder no such change seems to take place. During the changes in the nitrogen Kinch and Kellner both found that a large proportion of the nitrogen of the fresh plant was lost, or did not appear in the analyses.

With grass it was 13 per cent., with mangold leaves 27.8 per cent., in

the unpressed ensilage in a jar, and as much as 59.8 per cent. in that compressed in open silo. The latter high percentage is doubtless due to the carrying away in the expressed juice of much soluble nitrogenous substance. We have but few quantitative data in regard to maize, but have found that in the samples of ensilage which have been examined there is a comparatively large amount of ammonia combined with the acids produced by fermentation, acetic and lactic, which, of course, is lost in drying specimens for analysis. This produces in the result an apparent loss of nitrogen in the ensilage itself. It is at any rate a loss of nitrogen of nutritive value. A quantitative determination of the ammonia salts in one specimen of ensilage (Serial No. 1693) gave the following results:

Weight of ensilage taken	4,000.
Equivalent to dry substance	620.
Weight of NH_4Cl obtained	8.660
Equivalent to nitrogen	2.266
Per cent. of nitrogen from dry substance	.366
Per cent. of albuminoids equivalent	2.287

That the nitrogen was in the form of ammonia, and not a more complex amine, was proved by the following analysis:

Weight of ammonia salt taken	.1000
Weight of double platinum salt found	.4105
Equivalent to NH_4Cl	.0990

This ammonia salt, probably acetate, would be lost in the process of drying, and produce a corresponding deficit in the relative percentage of nitrogen in the analysis. In fact, 2.29 per cent. of albuminoid in the dry substance of an average maize stalk containing 7.50 per cent. amounts to a little more than 30 per cent. of the total nitrogenous substances of the plant, and about the loss which Kellner found in his experiments with mangold leaves not under pressure.

The remaining non-albuminoid nitrogen is probably largely of an amide nature, as we have found, like Kellner, very small amounts of peptone bodies. Attempts, however, to separate any amides in a crystalline condition have resulted in obtaining only a sirupy nitrogenous substance.

The loss of nitrogenous substance from conversion to ammonia salts and decomposition in drying is relatively compensated by the large loss of carbhydrates, so that in the figures of analyses neither loss is prominent and the result is at first glance deceptive. The control, of course, lies only in an absolute knowledge of the weight lost by the fodder in the silo or the relative increase in one of the constituents which is less liable to change—as, for instance, the ash. But, as Kellner has shown, pressure is very liable to remove the soluble part of the ash on the juice expressed, and thus entire dependence cannot be placed on this element. At the New Jersey Experiment Station in 1881 an interesting experiment was carried on, in which the ash served as a basis for calculation without apparently largely vitiating the results. The results were published in the Annual Report of this Department for 1881-'82, p. 572.

The loss in this case was seen to fall upon the carbhydrates entirely, and to be as great for the dry fodder as for the ensilage. There is an apparent slight increase in albuminoids, which can be explained by the fact that the calculation is made as if no ash had been lost by being dissolved away or expressed in the two preserved samples. The experiment is remarkable as showing that in this case, quite at variance with other instances, the nitrogen suffered little or no loss, and that in fact the whole loss fell upon the carbhydrates. This may be due some-t to the length of time during which the maize was in the silo, as

all samples which we have examined have not been taken out for several months later. At least these results show how varied the conditions are, and how unsafe it is to generalize from any one experiment. In the analyses appended to this paper this point is made evident.

As to the nature of the fermentation and the proximate principles involved I have made some observations. In but one sample out of many examined has any trace of *Saccharomyces* been found. As a rule the juice expressed from the fresh ensilage is swarming with *Bacillus subtilis*, together with some species of *Bacterium* and *Micrococcus*. No signs of a viscous or lactic ferment have been observed. The fermentation does not appear, therefore, to be of an alcoholic nature, or similar to any with which we are well acquainted. Analyses show the presence of an insufficient amount of alcohol, gum, or free acid for any of the usual forms, as can be seen from the following determinations.

Alcohol has not been found absent in any of the ensilages experimented with, but in all was present in such small amount as to be distinguished only by the iodoform test.

Lactic acid has always been detected, but never in very large amounts.

Acetic acid is the chief acid of the ensilage. The relative proportion of the two acids in the ensilage varies largely, the percentage of acetic being always greater.

Serial number.	Lactic acid.	Acetic acid.
	Per cent.	*Per cent.*
1003	Traces.	2.12
1004	.15	1.59
1500	.52	.80
1501	.24	Undetermined.
1502	.26	1.02
1677	.13	Undetermined.
[illegible]	.11	Undetermined.
1540	....	*2.40
1541	....	*1.22

* Total as acetic acid.

The whole amount present varies from one to a little over two per cent., the lactic not rising above six-tenths of one per cent.

The presence of lactic acid was determined by expressing the juice from a specimen of ensilage, distilling off the volatile acetic acid by repeated distillations, and neutralizing with zinc carbonate. The crystals of zinc lactate which were obtained on evaporation were recrystallized and analyzed. They contained—

Constituents.	Analysis.	Theory. $(C_3H_5O_3)_2Zn+3H_2O$.
Water	18.46	18.18
ZnO	26.71	27.27

Gum or similar substances are not formed in any large amount in the silo.

Sugar unchanged from the original cane has been found in the juice expressed from two ensilages, but as a rule it completely disappears. No. 1003 contained 2.40 per cent., No. 1004 1.07 per cent., and No. 1541 .76 per cent. of reducing sugars. The fiber is, of course, increased in relative amount, but absolutely it probably is but slightly altered.

In the following table analyses of a number of ensilages are presented together with those of a dried fodder, and several green stalks at various stages of development. From them much may be learned as to the variations to be expected.

The composition of the stalks of green maize is subject to very wide variations, as may be seen from the few analyses quoted. This, then, is a primary cause of differences in the composition of the ensilage, and while it is due largely to the period in its growth at which the stalks are cut, yet in those of the same stage of development there are often marked differences in composition even in the same field.

In a series of analyses of the stalks of Egyptian sugar and Lindsay's Horse-tooth maize, completed by me and published in the Report of the Commissioner of Agriculture for 1881 and 1882, p. 564, these variations are shown. The specimens, the analyses of which are here given, were all from a small plot of carefully cultivated stalks only a few rods square, and yet they show the largest deviations from a regular series in many instances.

The variations which are found in the composition of the stalks, while they are in a condition to be packed in silos—that is to say, from the appearance of the tops till the grain is well formed—are included within the following limits:

Constituents.	Highest.	Lowest.
Water in green substance	91.60	79.10
Dry substance	20.90	8.40
Ash	9.72	3.54
Oil	3.48	1.68
Carbohydrates	69.40	50.60
Crude fiber	31.29	21.56
Albuminoids	11.53	1.67
Per cent. of nitrogen as non-albuminoid	70.04	18.00

These limits, together with a study of the individual analyses, serve to show the primary cause of the difference in ensilages.

As to variations produced by other causes, illustrations are found in ensilages numbered 1652, 1653, 1677, and 1693—1652 and 1653 are analyses of ensilage from old and young stalks. The younger would naturally contain more ash and albuminoids as it went into the silo, but the nitrogenous substances would be in a condition making them more liable to conversion into ammonia salts from the greater amount of soluble nitrogen. This is the case with No. 1652. In it the ash is higher than in the older ensilage, but the nitrogen is lower from a greater loss. The relative amount of non-albuminoid nitrogen is also lower in the younger than in the older sample. In other respects they do not differ largely, although one was from stalks on which the ears were well formed and the other from stalks on which the ears had made no appearance.

In comparison with the ensilages the dried fodder No. 1654, from stalks of the same field as the old ensilage 1652, shows several advantages. As has been already remarked, its nitrogenous constituents have not suffered so much change, only 15.6 being in a non-albuminoid form as compared with 53.3 and 47.1 per cent. in the ensilages. A smaller loss of carbohydrates has left the relative percentages of fiber, fat, and ash low, and the evidence points to the fact that the stalks must have dried rapidly and with few changes, furnishing a fodder of much better composition than that analyzed in New Jersey.

In Nos. 1677 and 1693 we have analyses of two specimens of ensilage taken from the same silo within a few days of each other. One has lost more ash and nitrogen than the other, and this is due probably to greater pressure on the first sample, which has expressed juice carrying with it nitrogenous substance and ash. In other respects they are much

alike. The variations in composition which are found among the analyses lie within the following limits:

Constituents.	Highest.	Lowest.
Water	84.80	70.60
Ash	2.01	.91
Oil	1.80	.79
Carbhydrates	15.37	7.75
Fiber	7.54	2.85
Albuminoids, N × 6.25	2.77	1.04
Per cent. of nitrogen as non-albuminoids	53.3	47.1
Dry substance	15.20	29.40
Ash	8.87	5.68
Oil	9.12	5.08
Carbhydrates	61.84	48.43
Fiber	28.58	18.76
Albuminoid N × 6.25	11.97	5.97

By comparison with the extremes for green stalks it is seen that the albuminoids are higher in the dry substance of one of the ensilages, No. 1502, than in the dry substance of any of the stalks. The high figure in the ensilage is probably only relative, due to great loss of carbhydrates, and little change of albuminoids. Exact quantitative experiments are greatly to be desired, in order that we may have some explanation of the interesting changes which are shown by what has been already done.

Analyses of ensilage.

Constituents.	1003. Virginia.	1004. New York.	1500. Maryland: Fresh.	1501. Maryland: Out 24 hours.	1502. Maryland: Nesbit.	1540. Virginia.	1541. Virginia.	1677. Maryland: Blair.
Original substance:								
Water	77.30	74.10	81.20	81.40	84.00	70.60	84.80	81.67
Ash	2.01	1.48	1.36	1.44	1.25	2.00	.91	1.04
Oil, &c	1.80	1.74	1.71	1.21	1.20	1.80	1.00	1.09
Nitrogen free extract	11.24	12.87	9.14	9.47	7.75	15.37	9.40	10.17
Crude fiber	5.71	7.04	4.88	4.84	3.88	7.54	2.85	4.64
N. × 6.25 = albuminoids	1.94	2.77	1.71	1.64	1.92	2.69	1.04	1.39
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Dry substance:								
Ash	8.87	5.72	7.21	7.76	7.83	6.81	5.98	5.68
Oil, &c.	7.91	6.73	9.12	6.49	7.53	6.12	6.60	5.96
Nitrogen free extract	49.50	49.69	48.50	50.90	48.43	52.26	61.84	55.50
Crude fiber	25.15	27.19	25.98	26.05	24.24	25.65	18.76	25.30
N. × 6.25 = albuminoids	8.57	10.67	9.10	8.80	11.97	9.16	6.82	7.56
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
In the et[illegible] extract:								
Non-v[illegible] free acid	Trace.	.56	2.77	1.28	1.65	......	......	.72
In the nit[rogen] free extract:								
Sugar[s] sol. w[ater], sol. 80 per cent. alc.	17.76	15.54	......	......	......	......	......	10.59
Subst. s[ol.] in wa[ter], per cent. alc. insol.	3.86	3.14	......	......	......	......	......	2.90
Gum, &c	2.10	2.89	......	......	......	......	......	2.91
In the album[inoid]s:								
Nitrogen	1.37	1.71	1.45	1.40	1.91	1.47	1.09	1.21
Non-alb. n[itrog]en	......	......	......	......	......	......	......	.54
Per cent. [of nitrogen] as non-alb	......	......	......	......	......	......	......	44.6
In the original [subs]tance:								
Acid, acetic	2.12	1.59	.80	......	1.02	2.40	1.22	......
Acid, lactic	Trace	.15	.52	.24	.26	......	......	.13
Juice, per cent	47.5	40.5	39.5	39.1	49.3	50.8	......	......
Specific grav[ity]	1.046	1.0335	1.0197	1.01	1.017	......	....	......
Sugars	2.40	1.07	.00	.00	.00	......	.76	......
Solids	......	8.14	4.67	4.27	4.03	......	......	......

Analyses of ensilage—Continued.

Constituents.	1693. Maryland: Blair.	1652. New York: Young.	1653. New York: Old.	1654. Dried fodder.	1628. Stalks for 1677 and 1693.	Stalks Egyptian corn (young). Anthers just out.	576. Silk out.	580. Ear formed.
Original substance:								
Water	84.50	82.64	78.62	27.25	85.96	84.90	83.20	80.20
Ash	1.04	1.14	1.21	2.12	1.87	1.11	.81	1.16
Oil, &c	.79	1.01	1.46	2.53	.52	.44	.46	.47
Nitrogen free extract	8.47	9.21	11.39	50.02	7.27	9.25	10.34	13.21
Crude fiber	3.86	4.96	5.80	12.75	2.48	3.04	4.38	4.37
N. ×6.25 albuminoids	1.34	1.04	1.52	5.33	1.90	1.26	.81	.59
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Dry substance:								
Ash	6.68	6.59	5.68	2.91	13.31	7.39	4.81	5.87
Oil, &c	5.08	5.84	6.82	3.48	3.71	2.89	2.75	2.35
Nitrogen free extract	54.64	53.02	53.26	68.76	51.77	61.25	61.53	66.72
Crude fiber	24.93	28.58	27.12	17.52	17.67	20.15	26.06	22.07
N. ×6.25=albuminoids	8.67	5.97	7.12	7.33	13.54	8.32	4.85	2.09
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
In the ether extract:								
Non-vol. free acid	.72	......	......	......	......	......	......	......
In the nitrogen free extract:								
Sugars, &c., sol. 80 per cent. alc. sol. water	8.34	......	......	......	10.02	20.32	......	......
Subst. sol. 80 per cent. alc. insol. in water	3.66	......	......	......	2.64	7.17	......	......
Gum, &c	3.58	......	......	......	2.64	2.39	......	......
In the albuminoids:								
Nitrogen	1.39	.95	1.14	1.18	2.17	1.33	.78	.48
Non-alb. nitrogen	.69	.51−	.54−	.18+	.46	......	.39	.29
Per cent. of N. as non-alb	49.6	53.3	47.1	15.6	21.2	......	50.6	60.5
In the original substance:								
Acid, lactic	.11	......	......	......	......	......	......	......

CONCLUSION OF THE CHEMIST.

In addition to the foregoing work an extensive investigation has been made by this division to determine the best method for estimating th sugar in milk, the results of which have been most satisfactory from scientific point of view, but which would not be of sufficient interest the public for insertion in this report.

The usual number of analyses of minerals, waters, and miscellane objects has also been made, and the results sent to parties interes These analyses are not made for the private use of the individua or purposes of gain, but only when they appear of some general int st. Even under these regulations much valuable time of the Bureau on sumed in such work, and I earnestly recommend that in as far a ssible in the future the Bureau be relieved of this burden. We uch the case, much greater progress could be made in those lines of esti tion which directly affect the great agricultural interests of the ntry.

Some special work in the sugar interests of the country, wh s now going on, I hope to be able to submit as an appendix to this ort in time to secure its publication.

REPORT OF THE BOTANIST.

SIR: I have the honor to submit the following papers upon subjects which have received the attention of the Botanical Bureau during the current year. They relate to plants which deserve consideration, some on account of injurious and poisonous properties, some for their medicinal qualities, and some for their rarity or limited location.

The medicinal plants of this country have lately been the subject of increased interest. A large and important industry has been developed in their collection and preparation for market in several States, and especially in the mountains of North Carolina and Tennessee.

A number of new medicinal plants have also been introduced from California, and a spirit of investigation is leading to many new discoveries in regard to the properties of such plants.

The question of the cultivation of our medicinal plants has been recently discussed, and in view of the large drain upon the natural or wild plants for commercial purposes, it would seem likely that their cultivation will soon become a necessity, even if it were not more profitable as a special industry.

Respectfully,

GEO. VASEY,
Botanist.

HON. GEO. B. LORING,
Commissioner.

LOCO WEEDS.

Since the development of the stock-raising industry on the great Western plains and in California it is well known that animals feeding on the wild grasses and other plants have been frequently attacked with symptoms of a peculiar character, which have been attributed to the effect of certain plants. This disease among cattle and other animals is commonly called "loco." Among the symptoms first noticed are loss of flesh, general lassitude, and impaired vision; later the animal's brain seems to be affected; it becomes vicious and unmanageable, and rapidly loses both flesh and strength. Frequently, when approaching some small object, it will leap into the air as if to clear a fence. The animal also totters on its limbs and appears as if crazy.

After becoming affected the animal may linger many months or a year or two, but usually dies at last from the effects of the complaint.

This diseased condition has been attributed to various plants, but mainly to a few which belong to the order *Leguminosæ*. Of these, two species of *Astragalus* have been ascertained in California, and in Colorado and New Mexico another species of *Astragalus* (*A. mollissimus*) and

a closely-related species of *Oxytropis* are generally charged with the trouble in question.

Dr. Rothrock (in Wheeler's Report) says:

The term *loco*, simply meaning foolish, is applied because of the peculiar form of dementia induced in the animals that are in the habit of eating the plant. Whether the animals (horses chiefly) begin to eat the plant from necessity (which is not likely) or from choice I am unable to say. Certain it is, however, that once commenced, they continue it, passing through temporary intoxication to a complete nervous and muscular wreck in the later stages, when it has developed into a fully marked disease, which terminates in death from starvation or inability to digest more nourishing food. The animal toward the last becomes stupid or wild, or even vicious, or again acting as though attacked with "blind staggers."

Several analyses have been made of the plants which are said to be the cause of this affection, but without satisfactorily ascertaining what is the peculiar poisonous principle. No antidote has been discovered. If the plants can be ascertained and exterminated, the trouble should come to an end; but, even if the plants are recognized, their extermination over large tracts of country will be difficult and expensive.

We append descriptions and figures of the two plants which, in Colorado and New Mexico, have been most frequently charged with the noxious effects.

ASTRAGALUS MOLLISSIMUS—*Loco Weed.*

A perennial herbaceous plant of the region of the great plains from Colorado to New Mexico, Texas, and Arkansas. It belongs to the order *Leguminosæ* or pea family. There are usually a great many stalks proceeding from a large strong root-stock. They are reclining toward the base and erect above. These stalks are so short that the leaves and flower-stalks seem to proceed directly from the root. They are branching at the base and give rise to numerous leaves and long stems bearing the flowers and pods. The leaves are usually from 6 to 10 inches long, composed of 9 to 15 leaflets (in pairs except the upper one). These leaflets are of oval form, ½ to ¾ of an inch long, of a shining, silvery hue, from being clothed with soft, silky hairs. The flower-stalks are about as long, or sometimes longer than the leaves, naked below, and at the upper part (¼ to ½) bearing a rather thick spike of flowers, which are nearly 1 inch long, narrow, and somewhat cylindrical, the corolla of a velvet or purple color, the calyx half as long as the corolla and softly pubescent. The flower has the general structure of the pea family, and is succeeded by short, oblong, thickish pods, ½ to ¾ inch long, very smooth and with about two seeds in each.

This is said to be less common than the next plant described (*Oxytropis*). PLATE I.

OXYTROPIS LAMBERTII—*Loco Weed.*

A plant belonging to the same family as the *Astragalus mollissimus*. It is about the same height, and like it grows in strongly rooted clumps, but it differs in having an erect habit, with shorter leaves and longer and stiffly erect flower-stalks. The leaflets are longer and narrower, about 1 inch long, by ¼ to ⅛ inch wide, and hairy especially on the upper surface. The flower stalks proceed from the root-stock, are usually 9 to 12 inches long, and naked except near the top, which has a rather close and thick cluster of flowers, much like those of the *Astragalus* in general appearance, but differing in some minute characters which separate it into another genus, and are succeeded by erect lance oblong, pointed pods, of about an inch in length. This plant is very abundant

on the high plains, and in the mountains ranging from British America to Mexico. The flowers are subject to much variation in color, some varieties being purple, some yellow, and others white. PLATE II.

MELILOTUS ALBA—*Sweet Clover; Bokhara Clover.*

A biennial plant of the order *Leguminosæ*, nearly related to the clovers. It has a long, tough root which penetrates deeply in the soil, sending out its fibrous branches long distances in search of nourishment. The first year of its growth it sends up a large group of stems from a single root. These reach a height of about 2 feet and are provided with an abundance of leaves. The second year it sends up more vigorous stalks, which develop many branches and grow to a height of 4 to 8 feet, according to the moisture which they are able to obtain from the soil. The leaves are trifoliate or composed of three leaflets, of which the terminal one is short stalked and the lateral ones nearly or quite sessile. They have a common stalk or petiole generally less than an inch in length. The leaflets vary in size; on the thrifty shoots of the first year they may be 1¼ to 1½ inches long and one-half inch wide, but generally they are about 1 inch long, of an oblong or oblanceolate form, with the margins finely toothed. It begins to branch quite low and continues producing many slender branches to the top. The smaller subdivisions of these branches, from 3 to 6 inches in length, are occupied with the flowers and finally with the fruit. The flowers are arranged on these branches in spikes coming out irregularly but pretty uniformly for the whole distance. They are very small, white, on very short pedicels, and reflexed or bent backward. They have the general structure of flowers of the order to which they belong, but the parts are so minute that they need some magnifying power to see all the details. They have a 5-toothed calyx, 5 irregular petals, 10 stamens, 9 of which are grown together so as to form a band, the 10th stamen free, with a small membranous, wrinkled, usually 1-seeded pod. These pods are very small, but as there are great numbers of them on the branches the result is a pretty large yield. PLATE III.

The plant is a native of the southern parts of Europe and Western Asia. From its prevalence in the latter situation it receives the name of Bokhara clover.

It has been cultivated to some extent in Europe, but is there considered greatly inferior to red clover on account of the large proportion of coarse and innutritious stalks. On soils that are suitable for red clover that plant will give better satisfaction, but it is said to be adapted to poor soils, and not only to yield a heavy crop of forage, but to be very useful for plowing under to enrich the soil.

In some parts of the South it has recently been considerably cultivated and apparently with satisfactory results. Bees are said to be very fond of the flowers, and hence it has been recommended as a honey-producing plant.

The following letter from Dr. R. H. Duggar, of Gallion, Hale County, Alabama, gives an account of his acquaintance with the plant and his estimation of its value:

GALLION, HALE COUNTY, ALABAMA, *June* 23, 1884.

DEAR SIR: With reference to the plant sweet clover, sometimes called wild lucerne, but more properly "*Melilotus alba*," or "Bokhara clover," I will state that about fifteen years ago I was attracted to it by noticing along some ditch banks, in comparatively poor soil, this plant growing vigorously; its deep dark green clover-like leaves ahead of other vegetation was specially noticeable.

I watched its growth and tried my horse to see if he would eat it. Passing along the same place again I observed where my horse had eaten before it had tillered out again with numerous vigorous shoots. A rain coming on soon afterwards, I sent my wagoner with a box and spade and had some dug up by the roots and put out at home in a Bermuda grass plat; and, although the tap root was cut, it grew finely and produced seed abundantly. Some of it I cut and fed to the different animals—horses, cows, and hogs—I had then on my place; all seemed to eat it readily. (This, I am satisfied, however, is an acquired taste, for some stock will not eat it at first, but become very fond of it when *wilted*.) I cured some, and found that, like clover, lucerne, and the pea vine, it would readily shed its green leaves in drying, hence it should be put away when partially dry only.

Stock seem to be very fond of it, and when cured will eat the very stalks with a relish, notwithstanding they appear so hard and uninviting. I presume it must cure with a reserved amount of sugary residue in the stalks and twigs, particularly if cut when just in bloom. The odor of the leaves when drying and the blooms are very sweet, and during this blooming stage the tops smell like a swarm of honey bees. Considering it allied to lucerne, of which so much was written in the agricultural papers, I sent some specimens of the plant to the "editors" of Country Gentleman and Cultivator, Albany, N. Y., for examination.

We have also growing with us during the winter and early spring another species of this same plant, called also sweet clover, *Melilotus vulgaris*, with a yellow bloom and strictly an annual, whilst one great recommendation of the plant *Melilotus alba* is its being a biennial growth, and if not grazed or mowed too closely and regularly, will reseed itself every second year, allowing two good cuttings of hay. I was for a long time at a loss to discover its origin, but meeting an old acquaintance, a former owner of the plantation where it first appeared, I was referred to Prof. H Tutwiller, of "Greene Springs Academy," whose letter I inclose to you. Until the last six or eight years this plant was treated as a worthless weed by many of our farmers, and you well know how I have embraced its cause and advocated its more general use against so much opposition; from a weed whose seed was not worth the gathering to many (though formerly I paid twenty-five cents per bushel for it) it is now worth $2.50 to $3 per bushel, and valued even with the oat crop.

There are many other uses to which this plant is applicable, not the least of which is its great value as a fertilizer, believed by some to be the equal if not superior to our common field pea. I could give you many references of its value, but this letter is even now too long.

Yours, very truly,

R. H. DUGGAR, *M. D.*

Mr. J. T. COLLINS.

TORREYA TAXIFOLIA—*Stinking Yew; Savin.*

A very rare evergreen tree, resembling the yew, growing in the northwestern part of Florida.

According to Dr. Torrey it is a tree from 6 to 18 inches in diameter and 20 to 40 feet high, with numerous spreading branches, having an appearance at a distance not unlike the hemlock (*Tsuga Canadensis*). The wood is said to be rather light, not very close grained, of a yellowish-white color, or in old trees of a reddish color like that of red cedar.

It has a strong and peculiar odor, especially when bruised or burnt, and hence it is frequently called in the country where it grows, stinking cedar; it makes excellent fence rails and is not liable to the attacks of insects. A blood-red turpentine, of a pasty consistence, flows sparingly from the bark, which is soluble in alcohol, forming a deep, clear solution, and when heated evolves a very powerful terebinthinous, but unpleasant odor.

According to Dr. A. W. Chapman it is found on the calcareous hills along the east bank of the Appalachee River, near the confluence of the Flint and Chattahoochee, and also on the banks of the Aspalaga River in the same district.

The foliage is much like that of the yew, but the leaves are broader and marked with two longitudinal lines. They are two-ranked on the branchlets, about 1 inch long, and one line wide, of a light green color, very rigid, and with a stiff sharp point.

The male and female flowers are borne on different trees. The male ones are in small roundish clusters in the axils of the leaves near the ends of the branches. The female or fertile flowers are solitary near the end of the twigs, very small at first but ripening into an oval, drupe-like fruit 1 inch or more long, with a tough, rather leathery exterior, next to which is a thin hard shell, and occupied by a seed similar in shape to a nutmeg, and, like that, mottled within.

It is a singular fact that this tree is nowhere else found than in the few localities above named, and even there is in danger of extinction. It belongs to an order of which there are but three other species known to exist, of which one is in California and two in Japan. It is believed to be a remnant of an early flora, when a more intimate land connection existed between the eastern and western continents. Plate IV.

Mr. A. H. Curtis, of Jacksonville, Fla., has recently investigated the locality of this tree, and he gives the following account of it:

Leaving the State of Georgia either by the Chattahoochee or Flint Rivers, we find ourselves on a turbid, rapid river composed of their combined waters and named the Appalachicola. Behind us, like a large island, rises the wall of verdure which recently separated these waters. The western bank is steep and of uniform height. A shady road follows the bank a mile or two, and affords a most beautiful drive. This road leads from Marianna and other settlements to a ferry. At the eastern end of the ferry is a yellow bluff, on which stands the ferryman's house. Here also is a steamboat landing for Chattahoochee, a village situated a mile or more from the river. Following the road leading eastward we cross about half a mile of wooded river bottom, under the shade of grand black oaks, water-oaks, sycamores, and cottonwoods. After crossing this bottom we commence the ascent of a long and tiresome hill. After traversing a poor gullied pine wood we find ourselves at the summit of the hill. Here there is as great a change of scene as if we had been transferred suddenly from the wild country of Eastern Tennessee to the wide-spreading cotton fields of Middle Alabama. In the foreground of the scene is the little village of Chattahoochee, and about a mile beyond are the old United States arsenal buildings, now used as an insane asylum. In the center of the village we find the house of Dr. Scull, who owns all the country we have passed through and much besides, a thousand acres or more, much of it being heavily timbered. From the doctor we obtain instructions for finding and permission to cut what he calls savin, which my axman calls stinking cedar, the same being called by botanists *Torreya taxifolia*. Taking a northwestern course from the town, after passing through a dense woodland we find near the base of a steep rocky hillside the object of our search. There can be no mistaking the trees, for they are very different from anything we ever saw before—somewhat like the spruces and firs, more like the yew, yet very different. The leaves of the *Torreya* are about an inch in length, dark, shiny, rigid, and very sharp-pointed. They are borne in flat sprays, the lower branches nearly touching the ground. The fruit or nut of the tree is still more remarkable. It is about an inch in length, and resembles a green plum both in color and form. It is simply a naked seed, without a vestige of cone or other envelope. In this respect the *Torreya* and *Taxus* (yew) differ from our other conifers, and constitute a distinct tribe. The tree is pyramidal in form, of somber appearance, and appears strangely out of place in this latitude among oaks, beeches, and poplars. No doubt the *Torreya* is a relic of a past epoch, when it may have had a wide range at the time when the elephant and mastodon were denizens of this country.

In wood and bark the *Torreya* resembles the cypress—still more the firs. The wood is extremely durable, almost imperishable. Dr. Scull showed me *Torreya* posts which had been in the ground sixty years and were still quite sound. The wood, especially when freshly cut, emits a strong and offensive odor; probably this is also offensive to the "tooth of time." Most of the best *Torreyas* have been cut for post timber. About a mile south of the first locality I found another growth of these trees. Ten miles farther south there is a larger quantity, near the landing called Aspalaga, and it is also found on Sweetwater Creek, ten or fifteen miles farther down the river. Possibly it may grow in other spots, but I have no knowledge of its occurrence except at these three places near the eastern bank of the Appalachicola River.

TAXUS FLORIDANA—*Florida Yew.*

This species of yew occupies the same region of country as the previously described *Torreya*. It is a small tree, usually growing from 10

to 20 feet high, in some cases stated at 30 feet, and has much the appearance of the common yew of Europe. The leaves have the same general form and arrangement as those of the *Torreya*, but are shorter, narrower, and not so closely set on the twigs.

The flowers are likewise of the diœcious character and similar in structure, but the fruit is different, "consisting of a single ovule on a cup-shaped disk, which becomes large and berry-like in fruit and surrounds the nut-like seed." PLATE V.

NYSSA CAPITATA—*Ogechee Lime; Sour Tupelo.*

A small tree, 20 to 30 feet in height, growing from the Ogechee River, Georgia, south to Florida and west to Louisiana. Its usual situation is in swamps or on the rich banks of streams. The wood is soft and light and of no value. The leaves are 4 to 6 inches long, of an oblong or obovate form, narrowed at the base, entire, smooth, and green above, whitish and velvety pubescent below, on petioles less than an inch long, and irregularly placed on the branches. The male and female flowers are on separate trees, and appear at the base of the season's shoots; the male flowers in dense round clusters, and the female flowers singly on short peduncles. The male flowers have a 5-parted calyx and from 5 to 10 stamens; the female flowers have besides stamens a long style, and an ovary which ripens into an oblong red drupe from an inch to an inch and a half in length, with a thickish skin, an intensely acid pulp, and an oblong deeply channeled stone.

This fruit makes an agreeable conserve and substitute for limes. PLATE VI.

JUNIPERUS VIRGINIANA var. FLORIDANA—*Florida Red Cedar.*

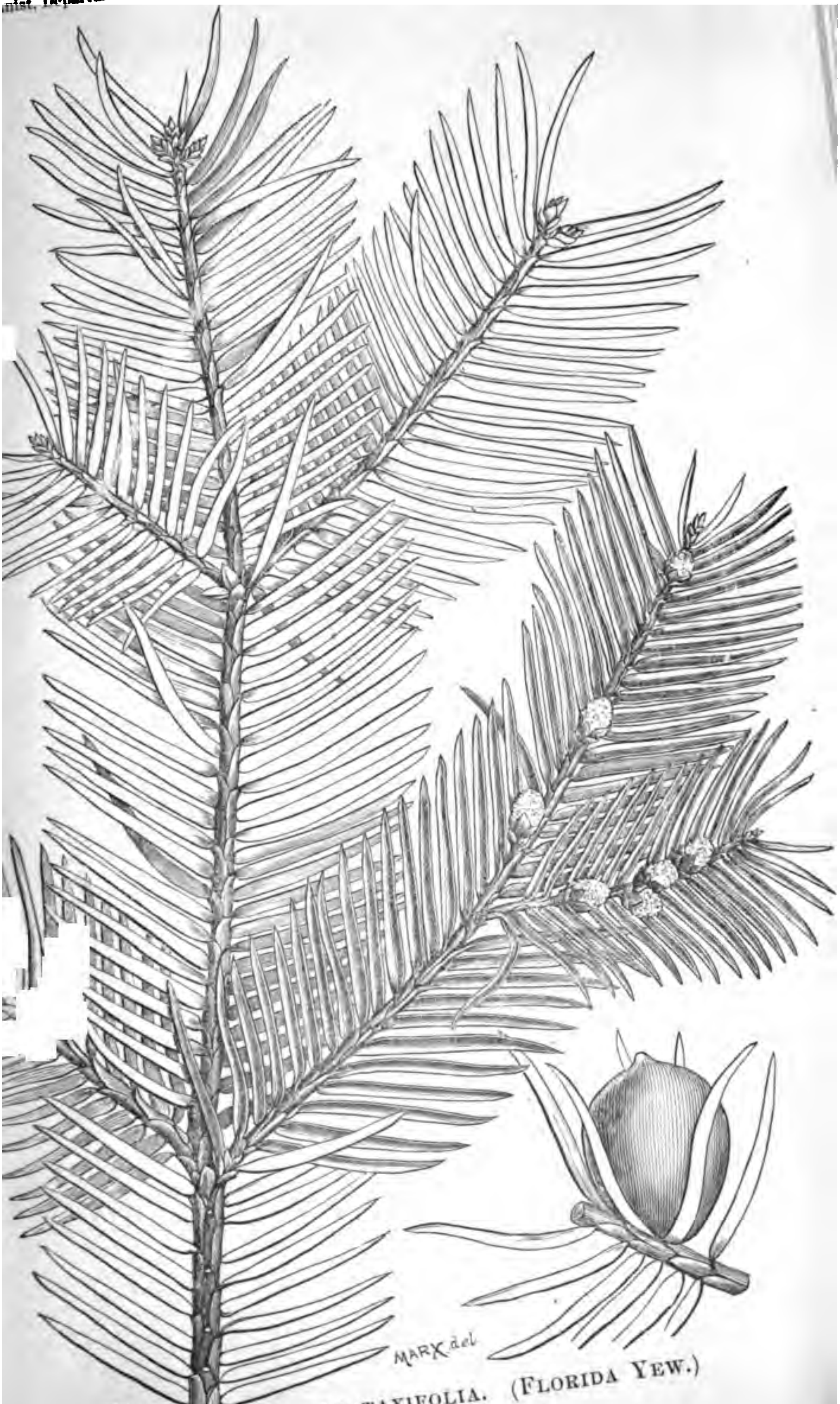
A variety of red cedar (*Juniperus Virginiana*) occurs on the rocky coast and keys of Florida, which furnishes a very soft wood, free from knots, and on that account used by the manufacturers of lead pencils, who send to Florida annually expressly for a supply of this wood. We present a figure of a twig. PLATE VII.

PINCKNEYA PUBENS—*Georgia Bark.*

This is a low tree growing from 15 to 25 feet high, with a diameter of trunk of 5 to 6 inches. It grows in clumps, a number of stems springing apparently from the same root. The young twigs and the petioles of the leaves are softly hairy. The leaves are opposite, and at their base furnished with small scales or stipules, which very easily fall away. They are 4 or 5 inches long, and 2 or even 3 inches broad, of an oblong form, pointed at the apex and base and supported on petioles or leaf stalks about 1 inch long. The upper surface is smoothish, the lower one is pubescent. The flowers are borne in clusters or corymbs at the ends of the twigs. These clusters are quite showy, not from the colors of the proper flowers, but from the presence of a number of leaf-like pinkish bracts of an ovate form and 1½ or 2 inches long. In some cases these bracts are developed from an expansion of the lobes of the calyx. The flowers are somewhat close in the cluster, about an inch and a half long. The calyx is small, with five narrow lanceolate lobes or teeth, which are only one third or one-fourth the length of the corolla. This is tubular and hairy externally. Near the summit it is divided into five linear oblong lobes which expand and roll backward, and are spotted with red. Aris-

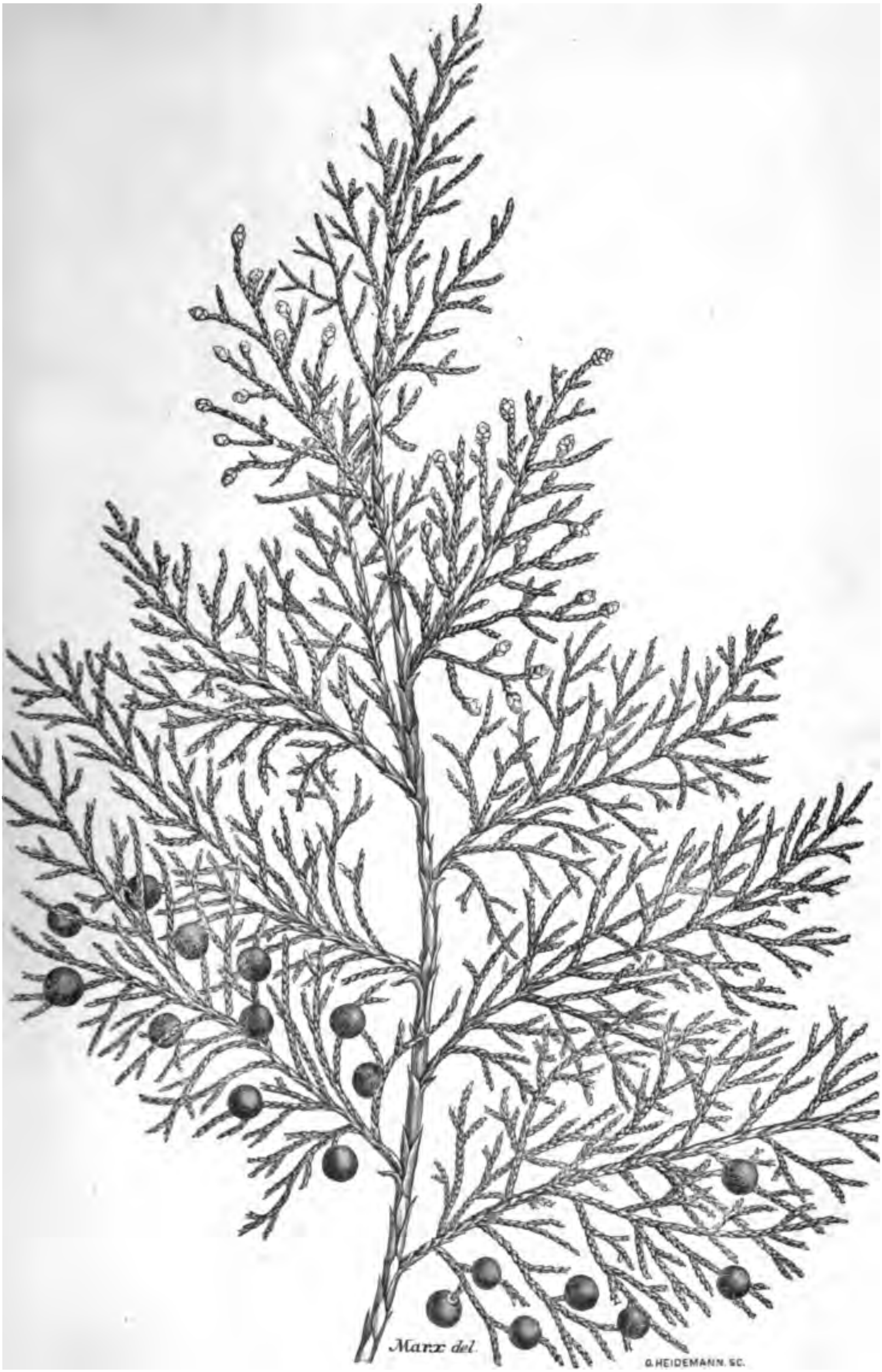
OXYTROPIS LAMBERTI (SMALL FORM).

MELILOTUS ALBA.



TORREYA TAXIFOLIA. (FLORIDA YEW.)

Nyssa capitata. (Ogechee Lime.)



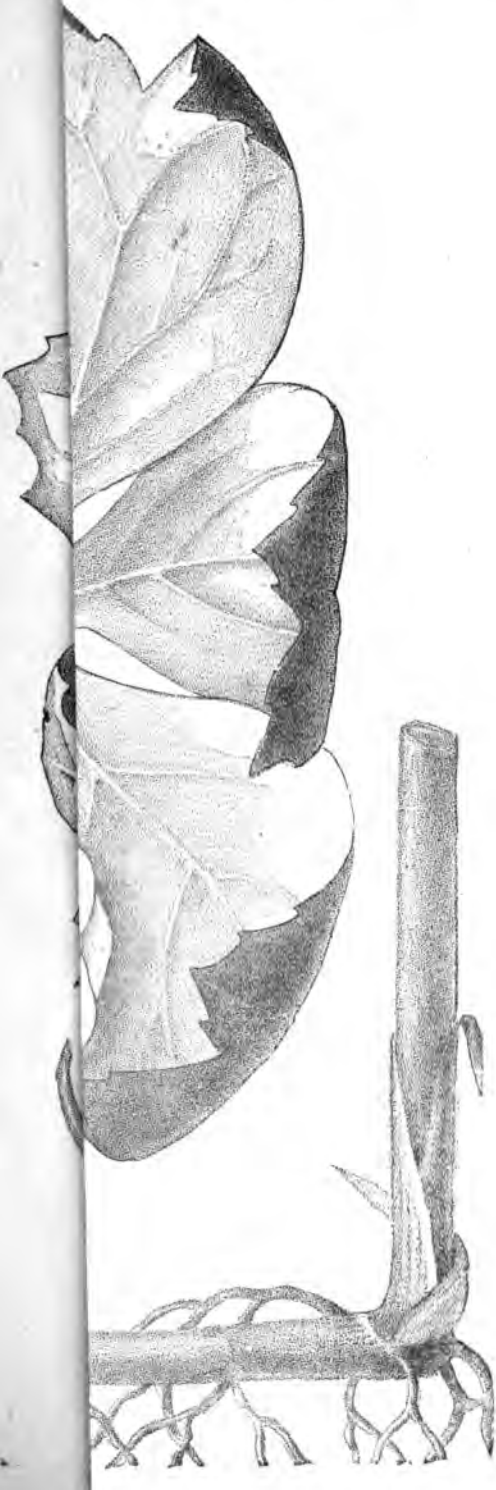
JUNIPERUS VIRGINIANUS, VARIETY.

Plate VIII.

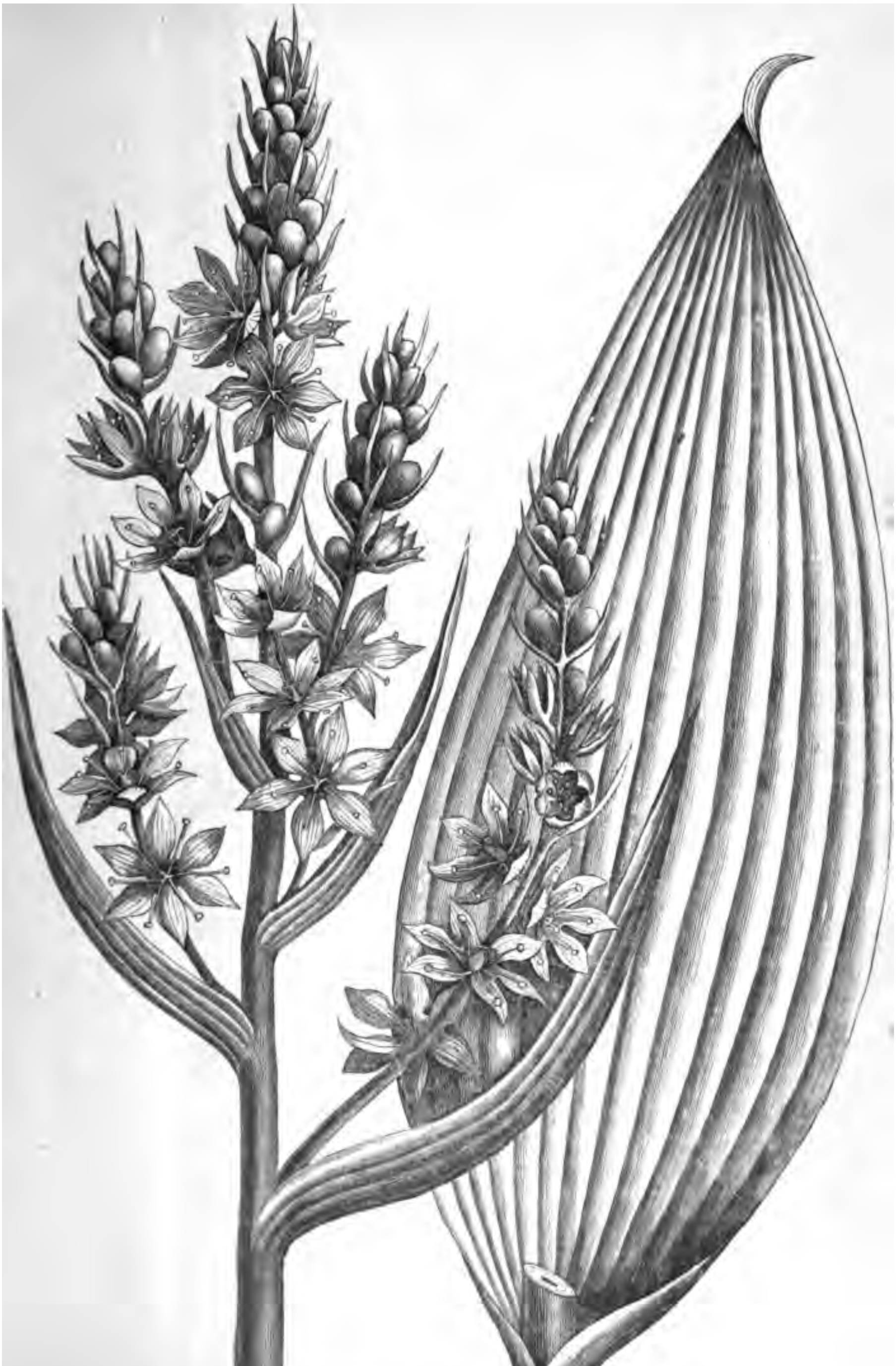
PINCKNEYA PUBENS.

ARALIA QUINQUEFOLIA. (GINS—

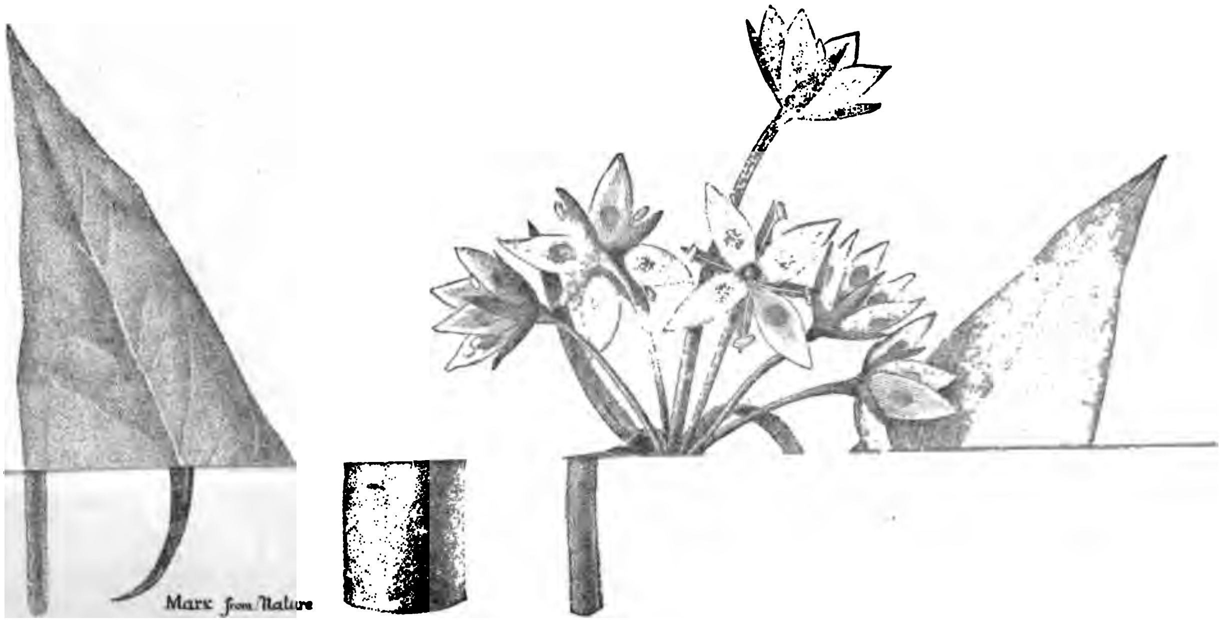
Plate X.



PODOPHYLLUM PEI



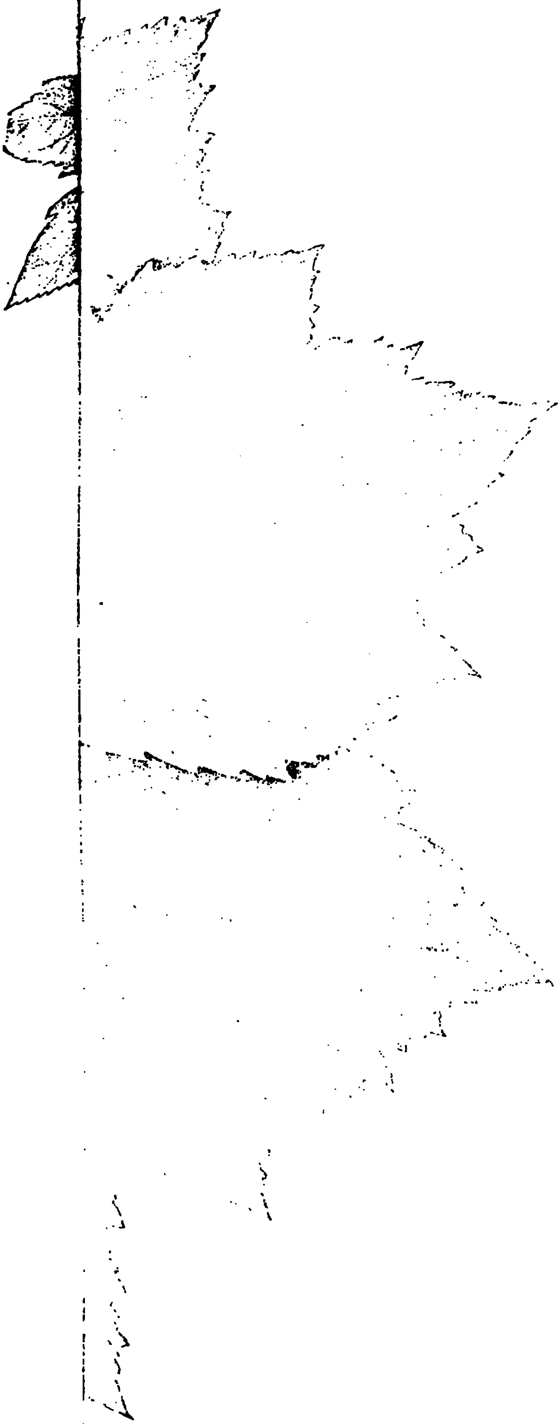
VERATRUM VIRIDE.



FRASERA CAROLINIENSIS. (AMERICAN COLUMBO.)

FRASERA CAROLINIENSIS. (AMERICAN COLUMBO.)

Plate XIII.



HYDRA

LOBELIA INFLATA. (LOBELIA.)

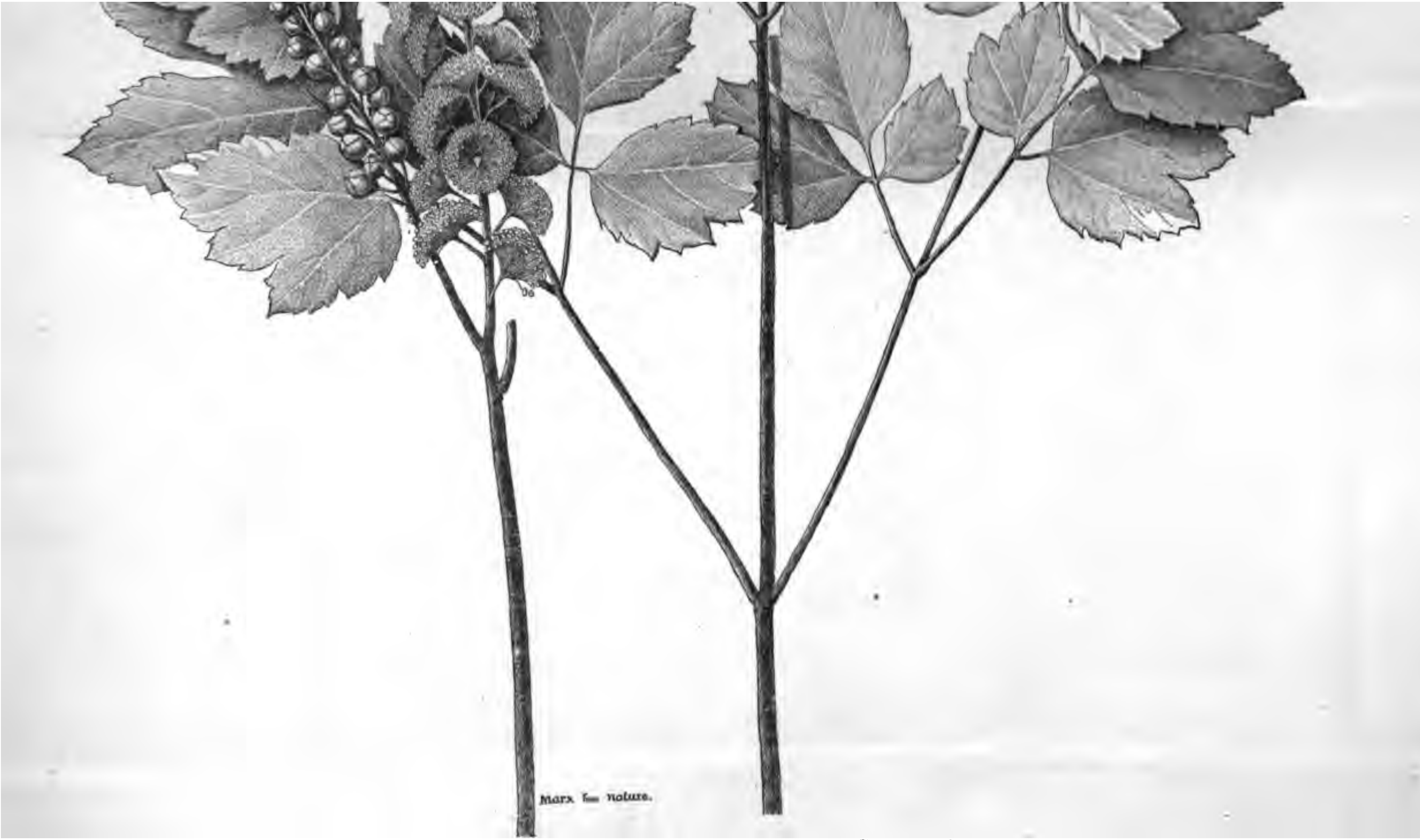
the Botanist, Department of Agriculture, 1884.

SANGUINARIA CANADENSIS. (BLOOD ROOT.)

C. HEIDEMANN SC

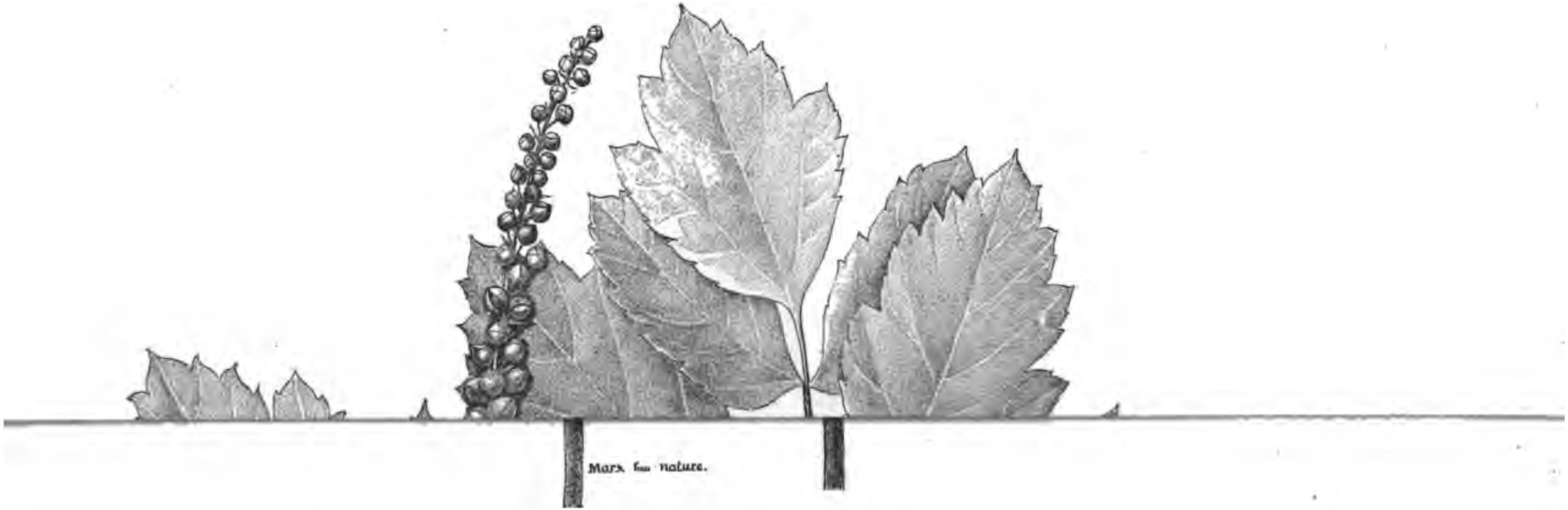
GELSEMIUM SEMPERVIRENS. (YELLOW JASMINE.)

SPIGELIA MARILANDICA. (PINK ROOT.)



CIMICIFUGA RACEMOSA. (BLACK COHOSH.)

Cicuta maculata.



CIMICIFUGA RACEMOSA. (BLACK COHOSH.)

CICUTA MACULATA.

POLYGALA SENEGA. (SENECA SNAKE-ROOT.)

ing from within the tube of the corolla and standing out beyond it are five stamens with small brownish oblong anthers, and proceeding from the center there extends beyond them the slender yellowish pistil, terminated by a small obtuse knob or stigma. All the external parts of the flowers are softly pubescent. At the base of the flower is a small swelling, which is the young ovary, and after the falling away of the flowers this ovary develops into a capsule ½ to ¾ of an inch in diameter, with thin but firm walls, which is divided into two cells, and when mature opens at the top and allows the fall of the seeds, which are thin, flat, winged, and closely packed in two rows.

The tree belongs in the natural order *Rubiaceæ*, which order also contains the genus *Cinchona* or the trees which furnish Peruvian bark, and some botanists have thought that this tree might be a member of the same genus, but there are differences in the structure of the flower and the pod which are sufficient to separate it into a distinct genus.

The bark seems to have analogous properties, is possessed of bitter and febrifuge qualities, and is used medicinally for fevers by the inhabitants of the country. The tree was first described by the elder Michaux, who collected it on Saint Mary's River in Georgia, in the year 1791.

It received the generic name of *Pinckneya*, in honor of General Charles C. Pinckney, of South Carolina, a gentleman who interested himself much in regard to the botany of his country. The tree grows in moist situations near the coast, from South Carolina to Florida. The flowers are developed in the month of June. PLATE VIII.

ARALIA QUINQUEFOLIA—*Ginseng*.

A low, perennial, herbaceous plant growing in rich woods in mountainous regions of the eastern portion of the United States. The stem rises from a tuberous root; it is naked and unbranched for 10 to 15 inches, when it terminates in a cluster of about 3 leaf stalks and a central peduncle or flower stalk. The leaf stalks or petioles are 3 or 4 inches long, and give rise at the end in an umbellate form to 5 to 7 leaflets, which are short-stalked and of unequal size, three of them being larger than the others, mostly obvate or oblong, in form thin, smooth, sharp-toothed, long-pointed, and 3 to 5 inches long; the other two to four of each stalk are much smaller and more irregular in form. The flower peduncle varies in length from 2 to 5 inches, and at the extremity terminates in a roundish cluster or umbel of small, short-stalked flowers, twenty to fifty in number, intermixed with short and narrow leaf-like scales. The individual flowers are small, but possessing all the usual parts of calyx, corolla, stamens, and pistils. The calyx is adherent to the ovary and surmounts it with five small teeth. The corolla is made up of five small oval white petals, which soon fall away. The flowers are not all perfect, some of them containing only stamens, others stamens and pistils. In the perfect flowers there are five stamens with small heart-shaped anthers, and usually two, sometimes three, persistent, outwardly curved styles. The ovaries finally expand into small, round, bright-red berries about the size of small peas.

The root is tuberous, 3 or 4 inches long, and usually dividing into two or three tap-shaped portions. It is wrinkled by parallel transverse ridges, and gives rise irregularly to a number of fibrous rootlets. The upper portion of the root-stalk shows several angular scars, the vestiges of previous stems which annually die to the ground, and are replaced by a new growth the following year. These tubers are generally buried sev-

eral inches in the ground, and grow very commonly at the base of trees in rich shaded forests. A species either identical with or closely resembling our plant grows in Northern China, and has for unknown ages been in use among the Chinese as a medical plant, and is believed by them to possess most extraordinary virtues, so much so that it is perhaps the most universal of all their remedies, entering into a large proportion of their prescriptions and commanding a high price.

Since commercia relations have been established with China large quantities of American ginseng have been exported to that country, where it has usually found a ready sale. At first the roots were procured from Canada and the New England States, but more recently large quantities have been collected and exported from the mountainous regions of North Carolina.

By medical men of our own country, this root is not believed to have any active medicinal properties.

It has an aromatic bitter-sweet taste, somewhat mucilaginous, and may be considered as a mild stimulant aromatic tonic. PLATE IX.

PODOPHYLLUM PELTATUM—*Mandrake; May Apple.*

A perennial, herbaceous plant growing throughout most parts of the Eastern United States in moist rich woods. What is commonly called the root of this plant is really a prostrate root-stock or stem, botanically called a rhizome, from which the true roots strike out at and near the joints. These underground stems sometimes extend for 3 or 4 feet in length, each year extending farther, and forming a joint or swelling, from which the next year's upright growth takes place. These upright stems are a foot to a foot and a half high, round and smooth, and dividing at the top into two large leaves, and in the forks between the leaves is produced usually a single flower. A portion, however, of the upright stems produce only a single leaf and no flower. These single leaves are peltate or umbrella-like, having the stalk fixed in the center of the leaf, with the veins spreading out from that point in all directions like the rays of an umbrella. The leaves of the flowering stems are one-sided, having the stalk fixed near the inner edge. They are mostly 6 to 10 inches in diameter, and divided into from five to nine lobes, the divisions reaching within an inch or less of the base. The lobes are somewhat obovate, wedge-shaped, sharply and coarsely toothed at the summit. The flower is nodding, on a peduncle an inch or two in length. It is nearly 2 inches in breadth when fully expanded. In the bud it is inclosed by three small green bracts which soon drop away, together with the six thin membranaceous sepals, leaving after expansion from six to nine white petals. These petals are obovate and spreading. The stamens are twice as many as the petals, on short filaments. The ovary occupying the center of the flower is crowned with a large sessile, crenate stigma. The flower is succeeded by a softish fruit of an oval form, about the size of a large plum, which has a thickish rind, becoming yellow when ripe, and a pulpy interior of an acid and agreeable taste, in which is embedded about a dozen small seeds. This pulp is much relished by many persons, and has cooling and aperient qualities. The long, creeping root-stalks, commonly called the roots, are the parts of this plant which are employed medicinally. When dried these are brittle and easily reduced to powder. They have a peculiar and rather unpleasant taste, becoming intensely bitter. This root has long been esteemed as a valuable medicinal article. It is in proper doses a sure and active cathartic, and is also believed to have an alterative influence

on the liver. It has an established place in the materia medica of this country, and is employed in the treatment of many diseases. PLATE X.

VERATRUM VIRIDE—*American Hellebore; Indian Poke-root.*

A coarse, herbaceous, perennial plant, growing from 2 to 4 feet high in boggy meadows and in low grounds along the margins of brooks in rocky and mountainous places throughout the Eastern United States. The stem is stout, erect, and leafy. The lower leaves are from 6 to 12 inches long, broadly oval, pointed smoothish or pubescent, with numerous nerves running nearly parallel from the base of the leaf to its apex, the lower part or stalk of the leaf clasping around the stem and with the edges growing together for an inch or two, so as to appear as if the stem passed through the leaf base. The upper leaves become gradually smaller and narrower, and at the base of the branches of the panicle they pass into linear bracts. The upper part of the stem for a foot or so constitutes the flowering panicle, with numerous alternate branches, the lower ones longer and spreading so as to give this part a pyramidal form.

The branches and terminal part are occupied with numerous and rather close sessile flowers. These flowers are not entirely perfect, some being only male and others male and female. The flowers are lily-like in structure, consisting of an envelope or perianth of six greenish, pubescent, ovate acute, small sepals, each narrowed at the base; six spreading stamens and three short recurved styles, terminating the ovary, which, when matured, composes a three-celled dry capsule, containing numerous small flattened seeds. The root of this plant, or more properly the base of the stem, is thick and fleshy, with numerous coarse fibrous branches or subdivisions. It has a sharp, biting, bitterish taste, and contains a resinous juice, which may be dissolved in alcohol. The plant is very similar to the white hellebore (*Veratrum album*) of Europe, which has long been employed medicinally in certain forms of rheumatism and gout. The first settlers of this country found that the Indians were acquainted with at least the emetic properties of our plant, and subsequent investigation led to the conclusion that it was as powerful in its action as its European relative. It has a strong influence on the action of the heart, and has been much employed as a sedative in fevers. It is, however, a dangerous medicine if used in large doses or by persons of weak constitutions, sometimes producing great depression, vomiting, and even death. It is one of the plants growing abundantly in the mountains of Carolina, and great quantities are annually gathered and prepared for market. PLATE XI.

FRASERA CAROLINIENSIS—*American Columbo.*

A tall, stout, biennial or triennial plant, growing in rich soil in open woodlands or in moist meadows. The root is large, spindle-shaped, fleshy, and of a yellow color. The second or third year the root sends up a strong, succulent, smooth, furrowed stem, from 3 to 8 feet high. The radical leaves (usually five to eight) are oblong or obovate, obtuse, a foot or more in length, and 3 to 4 inches broad, spread flat on the ground. The stem leaves are in whorls of four to eight, at intervals of 4 to 6 inches. Those at the lower whorls are oblong or lanceolate, entire, 6 to 8 inches long and 2 or 3 inches wide. They gradually become smaller as they ascend, and near the top are lanceolate and but 2 or 3 inches long. The upper part of the stem bears flowers at each of the joints, generally eight to ten at each joint, the lower ones on

branching peduncles 3 to 6 inches long, the upper ones singly on stems 2 to 3 inches long, the whole forming a panicle of pyramidal form. The flowers are about an inch in diameter when expanded, of a greenish yellow color. The calyx consists of four narrow lanceolate acute segments. The corolla is of a yellowish color sprinkled with small purplish spots. It is composed of four oblong abruptly acute lobes, each lobe bearing about the center a curiously fringed round gland. There are four stamens a little shorter than the corolla and situated on its base. The style is about as long as the stamens, with a short two-lobed stigma at the apex. The pod is oblong and flattened, pointed with the persistent style, of a firm, tough, texture, and about three-fourths of an inch long, contaning eight to twelve small, flattened, roundish, and wing margined seeds. This plant is found sparingly from Western New York and Pennsylvania to Wisconsin, southwestward to Missouri and Arkansas, and southward along the Alleghanies to North Carolina and Georgia. It is popularly known as wild or American columbo. It requires two or three years to come into flowering, which takes place from May to July. The root is of a sweetish or bitter taste, and has long been employed medicinally as a mild tonic similar in its properties to the columbo of Mozambique, but believed to be of inferior value to that plant, which belongs to a different natural order, viz., *Menispermaceæ.* PLATE XII.

HYDRASTIS CANADENSIS—*Orange-root; Yellow Puccoon.*

A small and rather inconspicuous plant of the order *Ranunculaceæ*, growing not very abundantly in rich woods in the Middle and Western States, and in the mountainous parts of North Carolina and Georgia. It is a perennial herb, seldom growing more than a foot high, with a simple hairy stem, with two or three small scale-like leaves at the base and two leaves near the top, one sessile, the other with a petiole, where the stem diverges so as to appear forked. The stem is terminated by a single, small, greenish flower. This flower, which is less than half an inch in diameter, has a calyx of three small sepals which drop off as soon as the flower expands. There are no petals, but a large number, sometimes forty or fifty stamens with thick filaments and very short anthers. In the center of these there are about a dozen small pistils, which finally develop into a round, close head of crimson berries, each of which contains one or two seeds. The two leaves are, when the flower expands, only an inch or two in diameter, but they continue to expand until they become 6 to 10 inches in diameter, being heart-shaped at the base, roundish in outline and divided into five to seven lobes, which are coarsely and doubly toothed. The root-stock is thick knotted and yellow, and gives rise to numerous thickish fibrous roots, which are also yellow. This root-stock and roots are the portions employed. The Indians used the roots for dyeing yellow. It is very bitter and has for a long time been employed as a tonic in domestic practice, and within the last twenty-five years has been admitted into the official list of the United States dispensatory, and its medical properties have been very fully investigated. It has been much employed in dyspepsia, in disease of the liver, in malarial fevers, &c. PLATE XIII.

LOBELIA INFLATA—*Lobelia; Indian Tobacco.*

An annual herbaceous plant growing in fields, open woods, and road-sides in most of the States east of the Mississippi, and to some extent

west of that line. It varies in height from 6 inches to 2 feet. The small plants are very little branched, while the large ones are much branched. The stem is erect, angular, and roughish hairy. The leaves are numerous, particularly on the lower part of the stem. They are scattered, of an oblong form, the lower ones 2 to 3 inches long, diminishing toward the top and becoming quite small on the branches. They are roughish, obtusely toothed on the margin, and without leaf-stalks. The branches vary in number and in length—commonly from 3 to 6 inches long, with the flowers arranged alternately toward the ends in spike-like racemes. The flowers are small, usually less than a quarter of an inch in length and with very short stalks. The flower is of the kind called superior, or seated above the ovary. The calyx consists of five small, narrow, linear segments. The corolla is of a bluish color, of five lanceolate segments, which are more or less united into a tube which is split down on the upper side, being somewhat two-lipped, the upper lip with two lobes and the lower with three. The five stamens are free from the corolla and united together by their filaments into a tube. The style is slender and partly inclosed in the tube of stamens. The ovary as it enlarges becomes a capsule much larger than the flower, sometimes half an inch long, ovate, two-celled, and filled with a large number of minute, brownish seeds. The leaves, capsules, and seeds of this plant when chewed cause a burning or biting sensation somewhat like the taste of green tobacco. If a sufficient quantity be taken and the juice swallowed it causes at length sickness and vomiting, the nausea being prolonged and sometimes attended with giddiness and pain in the head. The plant has been used not only for its emetic properties, but also in the treatment of asthma and catarrhal affections.

There are several other species of lobelia, some with large and handsome flowers, but they are rarely employed medicinally. PLATE XIV.

SANGUINARIA CANADENSIS—*Blood-root.*

A low perennial herb, with a thick fleshy prostrate root-stock, filled with a reddish orange-colored juice. The rhizoma develops near its extremity a few lateral as well as a terminal bud. Very early in the season—in March in the South, in New England in April—this bud expands and pushes forward a solitary leaf and a single flower-stalk. The leaf is at first rolled around the flower-stalk, and gradually unfolds, and continues growing for two or three months, when the leaf-stalk may be 6 to 10 inches long, and the leaf becomes 4 to 6 inches across, of a kidney form or rounded heart shape, very smooth, and divided into five to seven rounded and more or less obtusely toothed lobes. The single large flower, an inch in diameter when expanded, is at the end of a naked scape or stalk which is 4 to 8 inches long. The flower is extremely fugacious, expanding and falling to pieces almost the same day. It consists of two outside greenish ovate obtuse sepals, eight to twelve, oblong, spreading, pure white petals, twenty to twenty-four stamens, and the ovary tipped with a short style, and a thickish two cleft or grooved stigma. The ovary continues to enlarge after the fall of the flower until at maturity it becomes a lanceolate flattened pod about 2 inches long with two valves, and filled with numerous small shining dark red seeds.

The root-stock is half to three-fourths of an inch in thickness, emitting numerous small fibrous roots. It is easily broken across, and then displays a reddish surface from the quantity of juice which it contains.

The root-stock, or root, as commonly called, is thepart which is employed medicinally. It has been used in a variety of complaints, but chiefly those of the pulmonary organs. PLATE XV.

GELSEMIUM SEMPERVIRENS—*Yellow Jessamine; Carolina Jasmine.*

A smooth woody, evergreen, twining vine, growing on the margins of swamps and river banks from North Carolina to Florida, and west to Mississippi. It has opposite leaves, about 2 inches long, lanceolate, short petioled, entire on the margins, and acute at the base. The flowers grow in small sessile clusters in the axils or angle between the leaves and the stem, seldom more than half a dozen in a cluster. These flowers are 1 inch to an inch and a half long, of a bright yellow color, and fragrant. The calyx of the flower is small and five-parted. The corolla is monopetalous and funnel-shaped, with five spreading lobes. Each flower contains five stamens which are attached to the inside of the corolla near the base, and are about half the length of the corolla. There are two styles united together below, and nearly as long as the flower. After the fall of the flower the ovary develops into an oblong compressed, two-celled capsule, half to three-fourths of an inch long, which opens at the top and exposes several small oval, flat, winged seeds. The plant belongs in the natural order *Loganiaceæ*. This handsome vine possesses powerful medicinal properties. It has for a long time been popularly employed as a vermifuge in the Southern States, but within the last thirty years it has been carefully examined and investigated by physicians, and its employment has been extended to the treatment of many diseases. It is, however, a very active medicine, and requires to be employed with great caution, as it is capable of producing alarming and even fatal results in overdoses. The root is the part employed, but its active principle also resides in the flowers and probably in the leaves. It is a genus which is found only in America. It rambles over bushes, and low shrubs, sometimes ascending trees. It is one of the earliest flowers of spring.

"The flowers are deliciously scented, and fill the atmosphere with fragrance for long distances around. Though called jasmine in the South, it has no botanical relationship to the genus *Jasminium* or the true jasmines." PLATE XVI.

SPIGELIA MARILANDICA—*Pink Root.*

An herbaceous perennial plant growing from 1 to 1½ feet high in clumps of several stalks proceeding from a mass of fibrous roots. The stems are rather slender, somewhat four-sided, smooth, and furnished with three to six pairs of opposite, sessile, leaves. These leaves are from 2 to 3 inches long, ovate, smooth, entire on the margins and acutely pointed. The lower pair of leaves is smaller, and the upper is immediately at the base of the flowering raceme. This raceme or spike is 2 to 3 inches long, with usually eight or ten flowers arranged on one side. The flowers are sessile, with a calyx of five slender linear lobes, and a tubular funnel or trumpet-shaped corolla, 1½ to 2 inches long, bright red outside, yellowish within, and divided into five narrow segments at the top. The stamens are inserted on the inside of the corolla tube and reach nearly to its summit. The style is simple and a little longer than the corolla. The flowers are succeeded by short two-celled pods containing a few small seeds. The plant is most common in the Southern States, but is occasionally found in the Middle and some of the Western States. It is said to be not very abundant even in the South. It grows in rich dry soil in open woods. The root is the part which is principally employed in medicine. It has considerable reputation as a vermifuge. It is said that its virtues were first learned from the Cherokee Indians. Several eminent medical men of Carolina made trial of the plant more than one hundred years ago, and introduced it

to the notice of the medical profession generally; and it has since held a place among anthelmintic medicines. The roots are gathered for the markets in July and August. PLATE XVII.

CIMICIFUGA RACEMOSA—*Tall Snake-root; Black Snake-root; Black Cohosh.*

A plant of the natural order *Ranunculaceæ*; a tall, herbaceous perennial, growing in rich woods in nearly all the wooded and mountainous districts of our country. The stem is smooth, stout, and from 3 to 6 or sometimes 8 feet high, bearing two to three decompound leaves near the middle, and above and below naked. The stem terminates in a simple or sparingly branched spike-like raceme of small white flowers. There also spring from the root two or three large leaves on long stalks. The entire leaves with their stalks are a foot or two in length, divided into three main stalked branches, these each again divided into three or five smaller sections, each of which is composed of three ovate, coarsely toothed or lobed leaflets 1 to 3 inches long. The raceme of flowers is often a foot and sometimes 2 feet in length, sometimes with two or three smaller racemes. The flowers are small (about one-half inch when expanded), on slender pedicels about half an inch long, very numerous, sometimes as many as eighty to one hundred on the raceme. The lower flowers of the raceme expand first, then successively those toward the top. They consist of a calyx of four or five small, roundish petals (which drop off as soon as the flower opens), a multitude of stamens with slender filaments and small white oblong anthers, and one or several ovaries, of which only one matures into a dry oblong pod, containing numerous seeds. The white terminal racemes are very conspicuous when in flower. The root-stock is said to be mucilaginous, somewhat bitter and astringent. It is large, thick, and irregularly branched. The common name is probably derived from a popular notion of its efficacy as an antidote to snake bites. It has long had some reputation in domestic practice in the treatment of various diseases, particularly rheumatism and dropsy, and sixty years ago began to be investigated and tried by physicians, and finally gained a prominent place in the materia medica, its power in cases of rheumatism, nervous diseases, and chronic lung complaints being well established. PLATE XVIII.

CICUTA MACULATA—*False Parsley; Poison Hemlock; Spotted Cowbane.*

An umbelliferous plant belonging to the same natural order as caraway and parsley. The root is perennial; the stem dies to the ground annually. It grows in swampy grounds and in low meadows in various parts of the country from the Atlantic to the Pacific. The plants of this family are characterized by having their flowers in what are called *umbels*, the flower stalks branching out in all directions from a common center like the ribs of an umbrella. Frequently these primary stalks are again divided into smaller or secondary *umbels* or *umbellets*, as in the caraway, parsnip, &c. Each one of the final divisions of the *umbel* bears a single small flower. These flowers are so much alike in the different species and genera of the order that it usually requires very careful study to distinguish them one from another. The flower is of the kind called *superior* or above the ovary. It has usually a very minute five-toothed calyx, a corolla of five small petals, alternating with five stamens, and two styles surmounting the ovary, which develops into two carpels commonly called seeds, which are usually flattened and placed face to face, as may be readily seen in the seeds of the parsnip or carrot. In the *Cicuta maculata* the umbels at the ends of the stem and

branches are usually 3 to 4 inches in diameter, frequently having thirty or forty slender *rays* or *peduncles*, each one of which at its extremity is again divided into as many short spreading rays, each of which bears a minute white flower, or when ripe a pair of seeds somewhat like caraway. The main stem of the plant is smooth, thick, somewhat spotted or streaked with purple, and hollow. It grows from 3 to 6 feet high, with numerous branches. The leaves are compound and composed of three to five divisions, each of which is again divided into three or five leaflets. The base of each compound leaf is enlarged and dilated so as partly to surround the stem. The leaflets are 1 to 3 inches long, smooth, oblong or lanceolate, coarsely toothed, and pointed. The root of this plant is a dangerous poison. It is composed of a number of oblong fleshy portions diverging from the base of the stem, frequently as long and as thick as a man's finger. It has a strong penetrating smell and taste. It is often mistaken by children for wild parsnip, or is supposed by them to be eatable, and every year the papers contain accounts of fatal poisoning from the use of the root. It is highly desirable that information may be diffused respecting this and other poisonous and deleterious plants, so that such accidents may be avoided. The root has been to some extent employed by medical men. Its effects are much the same as those of the European hemlock (no way related to the tree called hemlock in the United States), but it is now rarely used. The poison hemlock of Europe (*Conium maculatum*) is the plant whose juice was given to criminals in ancient Greece, and from which Socrates came to his death. There are several other plants of this order (*Umbelliferæ*) resembling the one described, some with and some without poisonous properties. It is best to avoid the use of all such as are not well known. PLATE XIX.

POLYGALA SENEGA—*Seneca Snake-root.*

A small perennial herb, growing in woods and rich rocky ground throughout the eastern portions of the continent. It produces a clump of stems from a thick, hard, and knotty root-stock, the stems growing from 8 to 16 inches high, very leafy and unbranched and terminated by a raceme about 1 inch long of small pinkish or white flowers. The leaves are lanceolate, smooth, entire, and scattered on the stem. The plant belongs to the order *Polygalaceæ*, sometimes called milkworts, of which there is a large number of species both in this country and the Old World. The flowers in the raceme are small, sessile, and crowded, irregular in structure, and approaching those of the order *Leguminosæ*. The parts of the flower are very small, and require the use of a magnifier to make them plainly observable. The calyx consists of five unequal segments or sepals, three petals more or less united together, six or eight stamens united by their filaments into a flattish band, and a two-celled ovary, which ripens into a small two-seeded pod. The thick knotty rhizoma and the roots springing from it are the parts employed in medicine. This root is said to have received the name of Snake-root from its employment by the Seneca Indians as an antidote to snake bites. Dr. Tennent, of Virginia, a hundred and fifty years ago investigated the properties of the plant and believed it to be useful in the treatment of pleurisy and pneumonia. The use of the root then spread in this country and into Europe, and was generally believed to have valuable properties. It is an ingredient in the medicine known as hive sirup, much used in the treatment of croup among children. PLATE XX.

REPORT OF CHIEF OF THE FORESTRY BUREAU.

SIR: I have the honor herewith to report the work of this Bureau for the current year.

That the establishment of the Bureau meets an important want is shown by the correspondence to which it has already given occasion. Letters from all parts of the country, and even from other countries, are constantly received, making inquiries in regard to matters connected with Forestry, such as the best methods of planting and managing trees, the value of different trees for various purposes, their adaptation to different soils and climates, the best methods of procuring, preserving, and planting seeds, and the like. Much valuable information on these and kindred subjects has been given to the country in reply to the letters received. As the need and importance of tree-planting is now extensively felt both in those parts of the country which are comparatively treeless as well as in those from which the forests have been or are being rapidly removed, the need of trustworthy information on the subject becomes very desirable. Such a space of time is necessary for the growth of trees, that mistakes, whether in respect to the character and value of trees or their management, are costly. It is not as when one is cultivating a crop which is to reach its maturity in a few months. In this case a mistake involves loss only for a brief season, and a better course may be adopted for the next. But a mistake in planting trees, or the adoption of a wrong method of cultivation, may entail loss for a lifetime. Most persons in our country also are without experience in forestry. The subject is new to them, and the Department in giving the requisite information is rendering them a service of the greatest value.

WORK OF THE AGENTS.

During the year the agents who were employed last year have continued their work. By means of circulars, in addition to those used previously, they have gathered a large amount of information in regard to the condition of the country, both in respect to its original supply of timber and in the increase or diminution since the period of settlement, as well as many facts of interest and importance as to the growth and cultivation of trees for forest purposes. The reports made by the agents have been compiled into a volume which will soon be available to the public. Abstracts of them have been made and are herewith presented.

PENNSYLVANIA.

In the grant made by Charles II to Sir William Penn, in 1681, he made no reservations of timber, as in some other colonial grants. An evidence of Penn's thoughtful care for the maintenance of the woodlands may be gathered from a provision incorporated in an instrument

bearing date July 11, 1682, entitled, "Conditions and concessions," offered to such as might become adventurers and purchasers in his province, viz:

Eighteenth. That in clearing the ground, care be taken to leave one acre of trees for every five acres cleared, especially to preserve oak and mulberry for silk and shipping.

By an act of the assembly of March 10, 1683, a code of laws was passed making provision for securing the rights of property in timber-lands and for their protection from fire by the following statutes:

CHAP. XCII. *Be it enacted, &c.*, That if any person within this province or territories thereof shall at any time after the publication thereof, presume to cut and fell any timber tree upon the land of any other person without leave, such person shall forfeit to the owner thereof five pounds for every such tree as aforesaid.

CHAP. XCIII. *Be it enacted, &c.*, That whosoever shall presume to set on fire any woodlands or marshes in this province or territories thereof before the first day of the first month, yearly, they shall yearly make good all damages that shall thereby happen to any of the inhabitants thereof.

In 1693 the penalty for cutting trees upon the lands of another was fixed at five pounds for black-walnut trees, fifty shillings for every tree of other timber, and double the value for fire or underwood.

These statutes, so far as they were intended to secure the maintenance of a portion of the woodlands, were not, so far as shown by records, observed in the subsequent grants of land for settlement, and clearings were made without restraint, as in other timber portions of the country.

In a region extending over so broad an area as this State, with the diversity of soil that exists, there is considerable variety in the species of timber trees.

Prof. Thomas C. Porter, in his sketch of the botany of Pennsylvania, suggests that the State might be divided into six botanical regions, in each of which, besides certain species common to them all, there were others that were limited to each particular section. He thus classifies the regions: 1. Southeastern. 2. Northeastern. 3. Northern. 4. Middle. 5. Western. 6. The Lake Shore region.

In the fifty-eight counties from which reports were received reference was made to the principal species used for timber and lumber; of these, chestnut was mentioned 48 times; oaks, without further specification, 31; hickories, 29; maples, 27; white oak, 21; pine, 21; locust, 21; hemlock, 20; black walnut, 17; ash, 16; beech, 14; poplar, 8; black oak, 7; red oak, 7.

For many years, in the early history of the State, the principal supply of timber for market was floated down the Susquehanna River and its tributaries in rafts. This drained a region abounding in white pine. After a while the Allegheny River afforded the means for bringing down large quantities of timber, and for many years afforded occupation and employment for a large number of men.

Since the introduction of railroads the lumbering business has been extended into districts remote from the rivers, and the increasing demand has caused new supplies to be sought after, and much timber which had no market value has been brought in demand.

The white pine, which was regarded as the principal and most desirable kind of timber, has been exhausted in extensive regions where it was abundant, and hemlock and other species formerly considered of little value, are now the principal kinds sawed in the mills.

Timber has suffered very much from peeling off the bark for tanning purposes.

There are 1,569 saw-mills in operation in the State, and the estimated

amount of lumber cut in 1883, including 388,561,000 shingles and 183,740,000 laths, is 1,848,304,000 feet. These estimates are based upon the returns of correspondents.

In 1870 the percentage of woodland in the State was about 32 per cent. In 1880, 29 per cent.

According to the census of 1880 Pennsylvania stands second as a lumber-producing State, Michigan being the first.

From the returns to the circulars sent out by the Forestry Bureau, it is estimated that 95 per cent. of the area of the State was at one time covered with original forests consisting of oaks (all species), hickories, chestnuts, black walnut, ash, white pine, hemlock, birch, beech, maples, basswood, tulip.

Fully 70 per cent. of the original forests have been cleared, leaving about 30 per cent. in woodland, which corresponds with the census returns of 1880, or very nearly so; the census report shows 29½ per cent.

The clearing has been mainly for agricultural purposes, and while a large percentage of the timber cut off has been used for lumber for milling purposes, fuel, fencing, railroad ties, telegraph poles, tan-bark, and other domestic and manufacturing purposes, still very much that was valuable has been wasted, just to get it off the land. That which is now standing of the original growth consists mainly of jack pine, rock oak, birch, beech, maples, chestnut, hemlock, basswood, white wood, cucumber, ash, oak, and some pine.

The use of coal for fuel and the introduction of wire fencing stops a heavy drain on the forests, but the increased demand for railroad ties and lumber for milling purposes exceeds the saving for fuel and fencing.

The great demand for milling timber is causing much which is of an inferior quality to be cut, and as the future supply is from the natural growth only, which springs up voluntarily, it is not difficult to see that the supply will be exhausted in the near future.

The second growth is mainly oak, chestnut, hemlock, and pine.

Tree-planting is done but very little, except for shade and ornament.

There is no doubt that trees would grow and do well, but the money in an investment of that kind places the profits too far in the future for the average farmer. When people put money in an investment they hope to reap some of the profits during their lives, and seem to think if they have timber enough to serve them the generations following must look out for themselves. There is no kind of doubt but chestnut, locust, and black walnut would grow admirably, and soon make valuable timber, besides affording protection to the country by the increase of moisture, breaking of high winds, &c.

If the legislature, in order to encourage tree-planting, would offer a premium or small bounty for planting so many trees and keeping them alive for three or five years, and then exempt all woodlands from taxation, many would be induced to plant trees.

Forest fires do considerable damage, but not so much as formerly; more young timber, however, is destroyed by fire than any other cause. Fires originate in various ways, some by hunters from carelessness, and by sparks from railroad engines.

Timber growing now deteriorates much sooner than it did formerly; oaks stop increasing in value at 80 years, hemlock at 75, white pine at 120, chestnut at 30, locust at 25, poplar at 60, and the annual deterioration after these ages is from 1 to 5 per cent.

The suggestions as to what should be done by the General Govern-

ment for the preservation and increase of forests on the public domain are varied. The following are fair samples:

Establish a forestry department under the Commissioner of Agriculture, into districts of 5 to 10,000 acres. Place over each district one tolerably well versed in botany and general forestry, an educated person, who must reside on the land and devote his entire time and attention to his district. Ten or twenty of these districts to be under the supervision of one person, also educated in forestry, who shall report directly to the forestry department. In these different districts all timber grown should be manufactured in saw-mills, &c., on the land, first, for the use of the Government; secondly, for sale to the public; and make these forests not only self-sustaining, but a large revenue to the Government could be realized.

When the Government disposes of timber lands it should retain one-sixth of every section, thereby preventing the timber from being cut off. Then let Congress enact laws exempting exclusively timber lands from taxation, thereby holding out inducement to the owners to keep their lands in timber. The General Government might purchase portions of timber lands and hold them as such.

Institute a forestry department for the management of timber lands, under conditions of tree-planting, and forbid the cutting of timber under certain size. The *débris* of all trees felled should be cleared off, to guard against fires.

Organize a forestry commission, as is done in some of the European Governments, putting the forestry interests of the country in the hands of men competent to superintend and manage them successfully.

IOWA.

From the very large number of replies to circulars received from the regular correspondents of the Department and from private individuals, a pretty fair condition of forestry in the State has been obtained.

In compiling this abstract from these reports it is estimated that 23 to 25 per cent. of the area of the State was once in original forests, and consisted principally of oak, ash, elm, black walnut, hickory, cherry, and other minor varieties of the hard-wood species, together with birch, pine, maple, linden, poplar, and cottonwood, of the soft-wood varieties; the latter growing mostly on the banks of the rivers and smaller streams, and the former on the ridges.

Forty per cent. of the native forests has been cleared off and the greater portion of that remaining has been culled of the best timber, so that some of the varieties have almost entirely disappeared. That which is left is of inferior quality, and in consequence of this large numbers of mill-men are moving their machinery, while others are looking to other sources for supplies. In proof of this statement there is a falling off of 35,448,459 feet of boards and other sawed lumber in 1883, compared with the preceding year. In a State so rapidly developing as Iowa it is not presumable that this decrease is attributable to any decreased demand, from the fact that in many reports the correspondents append this note: "Mill stopped."

The clearing of the forests has been for lumber, fuel, manufacturing, agricultural, and domestic purposes, and for railroad ties in some portions of the State. When clearings have been made for purposes of agricultural development much timber has been wasted.

The introduction of coal as fuel has diminished the demand for wood for that purpose to a large extent, and the system of wire fencing, which is being adopted in many sections of the State, will diminish the demand for fencing purposes.

On lands where the timber was cleared off and left undisturbed a new and promising growth has sprung up which will largely supply the demand. In some counties the mania for hoop-poles has played havoc with young hickory and white oak. The amount of young timber growing naturally, including old fields that have been turned out, is estimated at about 25 or 30 per cent. of the original forests.

The possibilities and advantages of planting forest trees are good and growing, more especially in the prairie counties. The farmers generally are interesting themselves, and groves of 5 to 25 acres can be seen on almost every farm. The trees, which are mostly of the soft-wood varieties, are thrifty and seem to be doing well, and those interested are much encouraged. Much interest is being manifested in black walnut, which has almost disappeared from the forests, and which has the preference of all the hard-wood varieties.

In latter years very little damage has been done by forest fires. Sometimes the sparks from a railroad engine will drop on some combustible matter, from which a fire originates, but they are of very little consequence.

As to what should be done by the General Government for the preservation and increase of forests on the public domain but few express an opinion, and even these are varied. One says:

The State law exempting from taxation for timber-planting is the best.

Another says:

Sell no man more than 160 acres, and compel him to plant a specified number of trees before the title is perfected.

And says another:

While Congress shows so little concern for fostering material development no suggestion can be made as to the duty of the Government.

In the matter of the production of mills the reports show that in 1882 there were cut into boards and other sawed lumber 296,257,598 feet; in 1883, 233,809,139 feet, a decrease of 35,448,459 feet. Laths cut in 1882, 41,834,837; in 1883, 65,374,700, being an increase of 23,539,863. Shingles in 1882, 97,383,223; in 1883, 97,623,250, an increase of 240,027 over 1882.

MINNESOTA.

It is estimated that about 40 per cent. of the area of the State was at one time in original forest, and that from fully one-half of this the timber has been cut off for lumber, fuel, fencing, and railroad ties. Of the area cut off, about 15 per cent. is in new natural growth and is doing finely.

There is considerable tree-planting in some of the counties. The experiments show that it can be made successful, and the interest in it and the disposition to plant is growing, and the farmers are much encouraged.

Forest fires have done much damage, but few suggestions are made as to their prevention or control. Some say, however, that cultivation and putting down to grass for grazing are the best preventives.

The enforcement of existing law is a very general demand in the matter of preservation and increase of forests on the public domain. The views of four correspondents are suggestive, and are copied in full. Says one:

Laws will not amount to anything in the matter of preserving and protecting forests. The people must be educated up to a proper standard.

Says another:

Let the Government educate foresters as it does soldiers. Put an army of them to growing trees on public lands. When lands are sold charge the cost to the purchaser. Forever forbid the denudation of mountain and hill sides at sources of streams, small or great. Wherever climatological science points the way to save the country relapsing into a desert, or to prevent the destruction of valleys by inundation, these follow and assert control, national, State, or Territory.

Says another:

The General Government should set apart one section in each county that is organized, to be under the management of the county authorities, as an experimental farm or station, and largely devoted to forestry.

Says the fourth:

The Government will be powerless while the people send to Congress and the legislatures pine-land speculators and timber-thieves. All stumpage laws should be repealed, and timbered lands unfit for agriculture should be withdrawn from homestead and pre-emption, and disposed of as States dispose of school lands.

In the matter of production of mills, the reports show that in 1882 there were cut into boards and other sawed lumber 440,464,817 feet, and in 1883, 467,523,000 feet, being an increase of 27,060,183 feet over 1882.

Laths in 1882, 108,336,000, and in 1883, 110,570,000; an increase of 2,134,000 over 1882.

Shingles in 1882, 161,188,000; in 1883, 161,460,750; an increase of 272,750 over 1882.

CALIFORNIA, OREGON, AND WASHINGTON TERRITORY.

This abstract is compiled from a special report of the Hon. Robert W. Furnas, upon the investigations of forestry in California, Oregon, and Washington Territory, west of the Cascades.

The varieties of timber of most importance as to commercial value:

Pines.—Four kinds: The sugar, common, silver, and black-jack. The sugar pine grows 250 feet high and 8 to 10 feet in diameter; common, 170 to 180 feet high and 4 to 5 in diameter; silver, 150 to 160 feet high and 3 to 4 in diameter; and black-jack, 50 to 75 feet high and 1 to 3 feet in diameter.

Firs.—Four kinds: The white, noble, lovely, and yellow. White and yellow are most abundant and of most importance commercially. The yellow grows over 300 feet high, with a diameter of 12½ feet; white, 200 feet high and 5 to 6 in diameter; noble, about the same as white, while lovely, being less pretentious, grows to 100 feet in height and 2 to 3 in diameter.

Tide-water Spruce.—This variety grows 200 feet high and 8 to 10 in diameter.

Hemlock.—The Mountain variety grows to 100 feet high and 4 to 5 in diameter; Mertinsiana exceeds it in height 50 to 60 feet, with about the same diameter.

Tamarack grows 150 to 160 feet tall and 5 to 6 in diameter.

Larch is small.

Cedars.—Thin bark, thick bark, and Port Orford. The first is more common and grows 200 feet high and 5 to 6 in diameter; thick bark grows 100 feet high and 4 to 5 in diameter; Port Orford is very valuable and very limited. It is only found in some sections of Oregon, and is characterized by its durability and perpetual odor, and is proof against house moths and insects; in consequence of which it is in great demand for manufacturing chamber furniture. It grows 200 feet high and 6 to 8 in diameter, and the lumber is worth $60 per thousand feet at the mills.

Sitka cedar is also limited; being rare, it is very valuable. It is brought from Alaska.

Oaks.—Live, white, black, and chinquapin. Oaks on the Pacific slope are not so valuable as in other portions of the United States. The wood is coarse and brittle, the trees are low and inclined to spread, seldom reaching over 50 to 70 feet high, with short trunks; the principal use is for fuel.

Alder is quite abundant and grows to 80 or 90 feet high and 2 to 3½ in diameter. The timber is soft and light, somewhat like the linden. It is used extensively for inside work in furniture.

Oregon Ash is a strong and valuable timber, abundant in Oregon and Washington. It grows 60 to 80 feet high and 2 to 3 in diameter.

Large leaf Maple is found in abundance and is used for many purposes. The lumber is valuable, especially the "bird's eye" and "curled" varieties, which are used for veneering. It is quite a favorite in towns for shade and ornamental purposes.

Madrona is a beautiful hard wood and takes a fine polish. It grows 50 to 60 feet high and 3 to 4 in diameter.

Cottonwood is abundant on some of the rivers, grows to a good size, and is considered valuable for some uses.

Willows of several varieties, and of sufficient size to be of value, can be found in various localities.

Mountain Mahogany, cherry (black), manzinita, Chilian wood, choke cherry, quaking asp, dogwood, mountain ash, black haw, and serviceberry were observed.

Redwood is peculiarly adapted to the Pacific slope. It is the prevailing timber of commerce in California and Southwestern Oregon, and is of great value. Three important points in connection with it are worthy of consideration—the present supply, rate of consumption, and probabilities of reproduction. No exact data can be given as to the supply. The census of 1880 estimates the redwood in California, stand ing in the forests, at 25,825,000,000 feet, board measure. The yield per acre is much larger than of any other variety, and while the trees grow exceedingly thick, so thick that in many instances it is impossible to fell one to the ground, they also grow exceedingly large, and instances are cited where one tree produced 240,000 feet of lumber for all purposes for which its various parts could be used. Bayard Taylor, it will be remembered, reported a tree as yielding 250,000 feet.

It is estimated that in 1882 2,500,000,000 feet of lumber in its multiplicity of forms was consumed and handled in San Francisco, and 85,000,000 feet in Los Angeles. This vast amount came from California, Oregon, and Washington Territory.

But little attention has as yet been given to the reproduction of this valuable timber; still there is no doubt but it can be reproduced as readily as other varieties. Experiments on a small scale have been made and have proved satisfactory.

Eucalyptus, or Australian Gum.—Where the climate permits it has proven to be a valuable introduction, and the more that is known of it the more it grows in popular esteem. In addition to its sanitary and ornamental uses, it is good for fuel. It is sometimes called the "fever tree," because it is claimed for it that it possesses qualities that prevent malarial fever, also disinfectant virtues, and is an antiseptic for wounds, its essential oil being a stimulant, and the tannin in the leaves acting as a tonic astringent, when applied externally, hastens the healing of wounds. It is a rapid grower, but has also density of texture. It does not branch even where growing isolated, and is as durable as oak for railroad ties. The wood is compact, and owing to the resinous matter it contains is unusually incorruptible.

Mr. Elwood Cooper, of Santa Barbara County, California, has a plantation of over 50,000 trees, of thirty varieties. They show a growth in three years from a seedling to 9½ inches in diameter and 42½ feet high. At the same rate, in sixty years, a tree would be 16 feet in diameter.

FORESTS AND LUMBER OF WASHINGTON TERRITORY.

The investigation embraces about 30,000 square miles, lying between the Cascade Mountains and Pacific Ocean, and the Columbia River and British Columbia and Strait of Fuca. The principal portion of this region is covered with a dense growth of timber trees.

The firs, cedar, spruce, hemlock, and pine are used almost exclusively for timber. The pine, which grows to majestic proportions in Eastern Washington, is not found in the region of Puget Sound.

Arbor-vitæ grows along the Strait of Fuca. Fully 90 per cent. of all the lumber, timber, and spars produced on Puget Sound is fir.

White Maple is the most common of the deciduous trees; it is a beautiful wood, susceptible of high polish. Alder is white and soft, and is excellent for carving for furniture; the bark makes a red dye, and is used by the Indians for coloring purposes.

White Oak is much larger than in the Atlantic States, is light and at the same time elastic.

Laurel is very common.

There are three species of Poplar that abound, the Aspen predominating.

Willows grow along the river banks; only two varieties attain to any size.

The first saw-mill erected in Washington was located at Tumwater, in 1845, by Colonel Simmons. The falls of the Deschuttes River at this point furnish extensive water-power.

The first shipment of sawed lumber from Puget Sound was in 1851. The first steam saw-mill was planted at Seattle in 1853. There are now thirteen mills operating on the Sound, whose combined capacity per day is 1,002,000 feet. The demand for lumber is so great that the mills are run to their full capacity.

Great improvements have been made over the primitive method of logging and handling sawed lumber.

The finest timber region of Washington is yet unexplored. It lies west of the Willamette meridian, and is as large as the New England States. It is densely covered with stately Firs, and this vast timber tract is distinct from that east of Puget Sound.

The Samish, Skagit, Snohomish, Snoqualmie, Dwamish, White, Nisqually, and Puyallup Rivers empty in Puget Sound. The logs are "boomed" in the rivers and towed by tug-boats to the mills.

The demand for lumber is on the increase, and when railroads to the interior are opened up new markets will be added.

The question arises, How long will the supply last, with the increasing demand in contemplation? Bold writers assert that the supply in the Territory will never be exhausted; but personal observation warrants the assertion that the destruction of timber by fire has never been greater than it is in Washington, especially along the Sound. It is simply fearful, criminal. On the denuded lands trees spring up spontaneously, and thicker, seemingly, than the original; but a half or a whole century will be required before this growth is fit for use.

The General Government has done and is doing something to protect the timber and encourage tree-planting. Statutory laws are good as far as they go, and are a move in the right direction; but public opinion and interest must be awakened and educated to sustain and enforce the laws. How and in what manner this can be speedily and successfully done is yet an open question. The facts are manifest that the increased demand for and rapid consumption of timber, together with the wanton waste going on, are fast rushing us on to the verge of a timber famine.

LUMBER STATISTICS.

Reliable data concerning the timber now standing in California, Oregon, and Washington are not obtainable, and approximations even are unsatisfactory.

The product of the year 1882, exclusive of railroad ties, telegraph poles, and fuel, was as follows:

	Feet.
California	1,001,330,000
Oregon	283,248,000
Washington	724,214,000

Nine-tenths of the product of Washington are from the region of Puget Sound. Comparatively but little of this large amount finds its way to the Eastern States. Extensive shipments, however, are made to foreign countries.

INDIANA.

Full reports received from seventy of the ninety-one counties of the State, being well distributed, furnish sufficient data for the compilation of a very satisfactory abstract.

With the exception of about twenty-five counties forming a group, the entire State was originally covered with a heavy growth of timber, and the estimate, made up from the reports, places the area in original forests at 75 to 80 per cent., the growth being principally oak, hard maple, beech, ash, elm, walnut, cherry, poplar, hickory, hackberry, sycamore, buckeye, and other inferior varieties. About 55 per cent. of the original area in forests has been cleared, principally for opening up lands for agricultural purposes. In early days the object of the farmers and settlers being to get rid of the timber in the most speedy way possible, it was burned, and millions of dollars worth of the very best timber was thus destroyed.

The cutting of timber has been for lumber, staves, fuel, fencing, and other domestic and manufacturing purposes and for railroad ties, and has well-nigh stripped the forests of the most valuable timber; what remains is mostly of an inferior quality generally, only fit for fuel and fencing, and as in the old adage of locking the stable-door after the thief has stolen the horse, so with the forests, after the best and most valuable timber has been cut off and the land almost denuded of forests, the people begin to realize their importance and benefit and begin to use more discretion and economy and give more attention to their preservation.

The forests of young wood growing naturally will, in a measure, supply that which has been removed, for where land has been cut over and left unmolested a new growth springs up and grows rapidly. The area of this new growth is about 15 per cent. of the original clearing.

The climatic influences and changes by denudation or reinvestiture are observable. The denuding decreases the rainfall and water supply, increases extremes of heat and cold, while the reinvestiture has the opposite effect. Especially is this observable in the belt or group of counties having the smallest area of forests originally, and where more attention has been given to their promotion. There are several instances reported, where groves of timber have come into existence, in which springs of water have burst forth and flow on unceasingly where none had ever been known before, and others entirely drying out where the timber had been cut away and the land left bare.

In many portions of the State the planting of forest trees is receiving attention and the interest is growing. The planting of locust trees for

posts is proving so successful that groves of other varieties can be seen in many places and seem to be doing well. Some of the railroad managers are planting the Catalpa along the lines of the roads to supply ties in the future.

Forest fires formerly did great damage, but clearing off the undergrowth and putting the land in pasturage has served a good purpose in preventing forest fires, so that very little damage has been done of late years.

Some very old trees are still standing and are well preserved, which indicates that soil and other surroundings seem to have more to do with them than age; some show an age of 300 to 1,000 years, and indicate no deterioration. Oaks that appear to be in their prime, vigorous and healthy, are estimated to be 3,000 years old.

The amount of boards and other sawed lumber reported for 1883 is 159,983,000 feet, an increase of 30,341 feet over 1882. The number of shingles in 1883 is 4,300,000, an increase of 1,225,000 over 1882. The number of laths in 1883 is 12,612,000, an increase of 2,485,000 over 1882.

ILLINOIS.

Of Circular A, one hundred and twenty copies were sent out. To these, ninety-four replies were received. Two hundred and twenty-five of Circular B were sent, and one hundred and thirty elicited responses.

The circulars were distributed in every county in the State, and the reports received were from sixty-eight of the one hundred and one counties, or 68.3 per cent. of the whole.

When it is taken into consideration that Illinois is largely a prairie State, the reports are encouraging and show a growing interest in the subject of forestry.

Only about 45 per cent. of the area of the State was originally in forests, the growth being pines, oaks, walnuts, hickories, maples, beech, ash, poplar, elms, sycamore, linden, locusts, cherry, gum, and some other soft-wood varieties.

Fifty-five to 60 per cent. of the original area has been cut clean, and the most valuable timber cut out of the greater portion of the remainder. The clearing for agricultural purposes has not been as large as in some States, on account of the large area that was treeless, yet at the same time the organ of "destructiveness" seems to have been very prominent on the heads of some people, judging from the manner in which the destruction of timber has been carried on, by rolling it in heaps and burning it, simply to get it out of the way. The cutting has been for lumber for saw-mills, for fuel, fencing, railroad-ties, staves, wagon timber, and other domestic and manufacturing purposes, while large quantities of walnut lumber have been shipped. A large decrease in the products of saw-mills for 1883 is proof conclusive of the growing scarcity of good merchantable timber for milling. In some instances the second growth has been cut, and now the third is coming on. Quite a reaction has taken place within the past few years, and is growing very perceptibly, in regard to forestry. The use of coal as fuel and the introduction of wire fencing cuts off a heavy drain on the forests, and it is estimated that the new voluntary growth largely exceeds the original forest area. This, taken in connection with the fact that the farmers in the prairie districts are awakening to the interest of tree-planting, and that here and there groves of walnuts, locusts, chestnut, maples, catalpa, larch, Austrian pine, osage orange, and other varieties are growing successfully, shows conclusively that the possi-

bilities and advantages of planting forest trees are good, and ere long the planting will become general and the supply will equal the demand in all parts of the State.

The disposition to practice economy and utilize the whole of the timber when cut is fast taking the place of extravagance and wastefulness, and the friends of the forestry movement are more hopeful for the future.

The damage by forest fires has been very disastrous in former years, but their ravages seem to disappear as civilization and improvement advance, and no fires of consequence of a recent date are reported.

The deterioration of timber depends somewhat on the surroundings, but as a general rule pines are in their prime at fifty to one hundred years; oaks, at one hundred to one hundred and fifty; hickory, at twenty to sixty; maples, at forty to seventy-five; walnuts, at sixty to one hundred and fifty; poplar, at twenty to fifty. As a general rule timber deteriorates after one hundrd years at the rate of 20 per cent. per annum. In regard to the question of preservation and increase of forests on the public domain, but few will venture to make a suggestion.

One says:

> The Government should establish schools of forestry in every State to educate the young and rising generation, and appoint forestry overseers (honest men, who will do their duty) to look after the public domain.

Another says:

> A regular forestry system is the only possible plan to encourage, protect, and extend it.

And says another:

> Hang every rascal found stealing, and plant plenty of walnuts.

There is considerable falling off in the products of saw-mills for 1883 compared with the preceding year. In 1883 the cut was 148,719,271 feet, a decrease of 6,347,059 feet as reported for 1882. Shingles also fell off 4,618,000 in 1883, the number reported for that year being 17,100,000. In laths there was a gain; the number in 1883 was 26,750,000, being a gain of 4,860,715 over 1882.

WISCONSIN.

In the efforts to obtain full replies to circulars, the same obstacles are encountered in this as in other States.

About 75 per cent. of circular "A" and 40 per cent. of "B" received attention. Reports were from forty-one of the sixty-three counties of the State. The replies were generally pretty full and well distributed, which enables the compilation of a very fair abstract.

Of the whole area of the State, 85 per cent. was at one time in original forests, and consisted principally of oaks, pines, basswood or linden, elms, maples, walnuts, cherry, hickory, poplar, spruce, tamarack, beech, birch, cedar, and hemlock. Some of the hard woods were rather inferior compared with those from other States.

Fully 60 per cent. of the original forests have been cleared, and what remains has been closely culled of its most valuable timber. The larger portion of the clearing has been for purposes of agriculture, but a large quantity of timber has been cut for lumber, fuel, fencing, staves, piling, telegraph poles, railroad ties, hoop-poles, and other domestic and manufacturing purposes, while wasteful cutting and slashing has been carried on to an alarming extent. Within the last decade, however, the people are exercising more prudence and economy in cutting and using

timber, and more of it is utilized now than formerly, while the introduction of coal for fuel has greatly diminished the demand for wood.

Where the timber has been simply cut off and the land left undisturbed a promising new growth is coming on in many portions of the State. It is estimated that the new growth in the counties of Adams, Dane, Douglas, Greene, Juneau, La Fayette, Marquette, Pierce, Polk, Racine, Rock, Saint Croix, Sauk, Trempealeau, and others is equal to all future demands. In the prairie districts a growing interest in tree-planting is manifest, and many farmers are making successful progress in tree-culture. The possibilities are good, and there is no doubt that deciduous trees can be grown as well in Wisconsin as anywhere else. The only apparent difficulty is, the people do not realize the necessity at this time. They need to be educated to the importance of the subject.

No general fires of a recent date worthy of notice. Some counties, or rather portions of some counties, have suffered from fires, and among them Barron seems to have suffered most. In 1871 incalculable damage was done to the forests in some sections of the State, and the greater portion of the standing timber in the burnt districts is more or less injured; even the soil is injured so as to render it unproductive. One-third of the denudation in Douglas County was caused by fire.

The deterioration of trees depends more on the surroundings than the age. The best time to cut timber for durability is in the month of June. An instance is mentioned where rails of poplar and basswood split in the month of June thirty years ago are perfectly sound. A Bavarian, who has been a close observer, gives as the proper age to cut trees for different purposes as follows: Oaks—for hoop-poles, 5 to 8 years; wagon material, 8 to 16; machinery, 35 to 50; lumber and ship timbers, 50 to 75 years. Pines, average value at 75 to 100 years. Beech, 60 to 100. Hemlock, 45 to 75 years.

As to what should be done for the preservation and increase of the forests on the public domain, but very few suggestions are made.

One says: "Repeal all homestead and pre-emption laws and railroad grants, sell the land to actual settlers only at $1 per acre, give a bounty for every 5 acres successfully planted in trees, and exempt from State taxation for twenty years."

Another says: "Compel every person to keep a certain portion in timber of every tract patented."

The products of the mills reported are as follows: Boards and other sawed lumber for 1883 is 1,241,069,511 feet, being an increase of 136,151,842 feet over 1882; laths, 269,134,603, a gain of 50,839,453 over 1882; shingles, 658,692,700, a gain of 86,446,450 over 1882.

ABSTRACT OF THE SPECIAL REPORT OF HON. ROBERT W. FURNAS ON "TREE GROWTH, MAXIMUM SIZE AND AGE, PERIOD OF DECLINE, COMPLETION OF CYCLE, ETC."

The results of twenty-nine years' experience and observation in a region naturally timberless, and where successful efforts have been made in growing trees, are presented in a brief, plain, and practical manner.

The greatest objection to a prairie country is the want of timber for fencing and fuel, hence those who entered the "Great American Desert" after the passage of the Kansas-Nebraska act, in 1854, went to work and demonstrated the fact that they could raise their own timber.

The field of study is boundless when we start out to investigate the growth, maximum size, age, &c., of forest trees, and, as Pliny remarked

TABLE A.

	1 year old.	2 years old.	3 years old.	4 years old.	5 years old.	6 years old.	7 years old.	8 years old.	9 years old.	10 years old.	11 years old.	12 years old.	13 years old.	14 years old.	15 years old.	16 years old.	17 years old.	18 years old.	19 years old.	20 years old.	21 years old.	22 years old.	23 years old.	24 years old.	25 years old.
White elm	1/16	1/12	1/2	1	1½	2	3	4	5	7	9	11	13	15	16	19	22	25	28	31	34	37	41	43	46
Catalpa	1/3	2/3	2	3	5	7	9	12	15	19	22	24	25	27	30	34	30	43	48	52	54	61	66	71	75
Soft maple	1/4	1	2	3	4	6	7	9	11	13	17	19	21	22	25	27	32	35	38	46	52	58	60	68	72
Sycamore	1/8	1/4	1/2	3/4	2	3	5	7	9	11	13	16	19	23	24	26	28	29	30	32	35	38	40	44	47
Pig hickory	1/32	1/16	1/2	1/4	1	2	3	5	7	8	9	11	13	15	17	18	21	23	26	28	30	32	34	36	39
Cottonwood	1/3	1	3	4	7	9	12	16	19	27	32	37	43	45	49	56	64	72	81	92	100	111	120	126	134
Chestnut	1/8	2/3	1	2	4	5	6	7	9	11	14	16	19	24	25	26	28	29	31	33	36	44	48	52	56
Box-elder	1/3	1	2	3	5	6	7	9	11	13	15	17	19	23	25	26	27	32	34	36	39	41	46	47	49
Honey locust	1/4	1/2	1	2	3	5	6	8	9	11	12	14	15	16	19	21	23	26	29	34	38	43	46	48	52
Black locust	1/4	1/2	3/4	1	3	5	8	9	11	13	15	16	16	18	19	24	25	27	29	31	33	35	37	41	44
Coffee tree	1/3	1	2	4	6	8	10	12	14	16	18	19	21	21	23	23	24	26	28	30	32	33	34	36	38
Burr oak	1/32	1/11	1/4	1/2	½	1	2	4	7	9	13	16	19	21	23	24	26	28	30	33	36	39	41	42	44
White oak	1/32	1/11	1/2	1/4	1	2	4	6	9	11	13	19	20	22	24	26	28	30	32	34	36	38	39	42	44
Black walnut	1/16	1/8	1	2	4	6	9	11	13	15	17	19	22	24	27	30	33	36	40	44	46	48	51	54	56
Osage orange	1/4	1/2	3/4	1	2	4	6	7	8	10	11	12	14	16	16	17	18	20	22	23	26	29	31	33	34
White pine	1/3	1	2	3	6	9	12	14	17	19	22	24	26	28	31	33	35	37	39	40	42	44	45	47	49
Red cedar	1/4	1/2	1	2	4	5	7	9	11	13	16	10	22	24	27	28	30	32	34	38	41	43	45	48	51
Mulberry	1/8	1/4	1/2	1	2	3	5	9	12	15	18	21	24	26	29	30	31	33	35	38	42	44	47	50	52
Yellow willow	1/2	1	2	4	6	9	12	16	26	36	42	50	56	64	72	80	89	93	98	100	110	119	125	130	136

It will be seen that the annual growth is very irregular; this is caused by irregular seasons—some propitious, others contrary. The concentric rings in young trees are readily distinguished by the propitious or adverse season.

As the trees advance in age the inner rings decrease in size and almost disappear, and the growth of the tree diminishes after certain periods. Four beeches mentioned by Loudon show greater variability. One in King's County, Ireland, at sixty years, was 17 feet; one at Foster Hall, at one hundred years, was 12 feet; one at Contachy Castle, at one hundred and two years, was 18 feet; and one at Collander Park, at two hundred years, was 17 feet. Here are three about the same size; one is sixty years, another two hundred. This variability is still more conspicuous in the oaks. De Candolle, the Swiss botanist, counted the rings of several oaks that had been felled; one at two hundred years had attained the same circumference as another had at fifty. Some had grown slowly at first, then rapidly; others grew rapidly at first, then slowly. An oak three hundred and thirty-three years was shown to have increased as much between three hundred and twenty and three hundred and thirty as it had between ninety and one hundred years. This reduces the computation of the age of an oak to little more than guess-work.

The Cowthorpe oak, the largest in England, reached 78 feet in circumference. Damory's oak, in Dorsetshire, was only 10 feet less when it was so decayed that it was cut and sold for fuel in 1755. The Donnington oak, in the vale at Gloucester, was 54 feet at the base when burned down in 1790. It is therefore obvious, from the variable rate of growth, that the size establishes no indisputable title to age.

The following statistics from Loudon show great variability in the growth of oaks:

Years.	Circumference.	Years.	Circumference.
	Feet.		*Feet.*
40	8	200	7½
83	12	200	25
100	12	201	21
100	18	220	20
100	21	250	19½
120	14	300	33
180	15	330	27

When, therefore, Gilpin, in his "Forest Scenery," speaks of nine hundred years as no great age for an oak, it must be said that few can be named whose measurement would sustain the assertion.

In the matter of concentric rings, personal observation shows black locust, six years, with 12 rings; shellbark hickory, twelve years, 21 rings; pig hickory, six years, 10 rings; wild crab-apple, five years, 11 rings; chestnut oak, twenty-four years, 20 rings; American chestnut, four years, 9 rings; peach, eight years, 5 rings.

Dr. A. L. Childs, a gentleman of practical science and observation, in a contribution on "Concentric rings," published in the Popular Science Monthly, December, 1883, says:

In June, 1871, he planted a quantity of red-maple seeds, transplanted them in 1873, in 1882 cut out some. From day of planting to cutting was eleven years and two months. On one he counted forty rings very distinct, none less than thirty-five. The rings were distinct when the tree was first cut, and no mistake could possibly be made.

The Hon. James J. Wilson, of Bethel, Vt., an old lawyer and late senator in the State legislature, gives a case which occurred in the courts where it was decided that "the rings were not a sure indication of the age of a tree." That distinct concentric rings approximate, and in some cases agree in number with the years of a tree, no one will deny; but that intermediate or subrings, less conspicuous, exist, is equally true.

These sub or additional rings are easily accounted for by sudden and more or less frequent changes of weather, long intervals of extreme drought or cold.

Query: Has a tree grown in a conservatory or place of unchanged conditions of heat and moisture any concentric rings?

Thomas Meehan, editor Gardener's Monthly, in relation to annual rings, says:

> Northern trees, all hard wood, make many rings a year, sometimes a dozen, but the last set of cells in the annual growth are very small and the first very large, so it is an easy matter to determine the annual growth.

J. A. Farrar presents an elaborate paper in Longman's Magazine on the "Age of trees." In speaking of the attainable age of the cypress and its introduction in England, he says:

> It is first mentioned in "Turne's Names of Herbs," published in 1548, which makes it probable that it was introduced in England before the beginning of that century.

The cypress at Fulham, which in 1793 was 2 feet 5 inches at 3 feet above ground, could not have been planted before 1674, the year that Compton the Great, the introducer of foreign trees in England, became bishop of London; that gives a growth of about 2 feet the first one hundred years.

The cypress planted by Michael Angelo, at Chartreux, was 13 feet in circumference in 1817, an average of over 4 feet the first three centuries. The cypress at Sonuna, for whose sake Napoleon bent the road so that it should be spared, is not more than 23 feet in girth. The tradition that this tree is coeval with Christianity may or may not be true, but if 3 feet be taken as the first century growth, and take the third as the average, it was evidently standing at the time of Cæsar, as the old chronicle at Milan attests.

The Lebanon cedar, first planted at Lambeth in 1683, was 7 feet 9 inches in girth one hundred and ten years later. Dr. Uvedale's cedar at Enfield, planted in 1670, was 15 feet 8 inches in 1835, one hundred and sixty-five years after it was planted. The large cedar at Uxbridge, which was blown down in 1790, was one hundred and eighteen years old. When Gilpin measured it in 1776 it was 15½ feet. In 1696, Maundrell, the traveler, measured one of the largest cedars on Mount Lebanon, supposed to have been growing there in the days of Solomon, and found it to be 36 feet 6 inches. Four feet being the average rate a century, this tree could have attained its size in nine centuries, and may not have been older than the time of Charlemagne, and may have been much younger, allowing for the rapid growth on a site where it is indigenous.

The Fortworth Spanish chestnut in Gloucestershire is said to be the oldest tree in England. It bears an inscription to the effect that King John held a Parliament beneath it. Sir Robert Atkyns, whose history of that country was published in 1712, speaks of it as said by tradition to have been growing in the reign of King John. It is 57 feet in circumference and seems to be several trees incorporated together, and

young ones are still growing up, which in time may be joined to the old body.

Evelyn spoke of it as standing in the reign of Stephen, so that we may accept 57 feet as the maximum measurement. Now, a chestnut may attain 17 feet in its first century; for instance, the one at Nettlecombe. If, therefore, 15 feet be taken for the first century, then, on the principle of the third as the average, it would require eleven centuries for 57 feet; but this may be too low, for in 70 years it increased 2 feet in girth, and instead of eleven it may not have required but seven centuries when Sir Robert Atkyns declared it to be 57 feet.

The famous Castanea di Centobaville, on Mount Ætna, has a similar history. It is said that the Queen of Aragon and one hundred followers took shelter beneath it from a shower of rain. Brydone measured it in 1790 and found it to be 204 feet in circumference, but it was a question with him whether it was one tree or many. Murray's guidebook speaks of it as separate trees.

The Castanea del Nave is rather larger than the Tartworth. The rich soil has much to do with the growth, and it is impossible to conjecture whether they are five or ten centuries. The rate of growth is apt to be underrated when a tree meets with favorable conditions.

The silver fir was only introduced into England in the seventeenth century, by Serjeant Newdigate. One tree of his planting was measured by Evelyn eighty-one years afterward, and was found to be 13 feet in circumference.

A comparison of the statistics of growths, with reference to oaks, indicates a more rapid rate than is generally supposed.

It may be well to notice some of the oldest Limes. The Swiss very often commemorate a victory by planting a lime tree, so that it may be true that the lime standing in the square at Freyburg was planted on the day of their victory over Charles the Bold at Murat in 1476. It is said that a youth bore it as a twig into the town, and arriving breathless and exhausted from the battle, only had strength to utter the word "victory," and fell dead. But this tree was only 13 feet 9 inches in 1831, three hundred and fifty-five years after planting.

The large lime at Neustadt, in Würtemberg, mentioned by Evelyn as having its boughs supported by columns of stone, was 27 feet when he wrote (1664), and in 1837 it was 54 feet, so that within a period of one hundred and seventy-three years it had gained 27 feet, consequently it is fair to presume that two hundred years was more than enough for it to have attained 27 feet. No English lime appears to have reached such dimensions, though the one at Depeham, near Norwich, was 46 feet when Sir Thomas Browne sent his account of it to Evelyn, which exploded the legend that all limes in this country came from two plants brought over by Sir John Spelman, who introduced the manufacture of paper in England.

It is natural to expect the greatest longevity in trees indigenous to any climate, though it has been disputed. Tradition, however, does not always give satisfaction in estimating the longevity of trees. Tacitus calculated that a fig tree was eight hundred and forty years old because tradition marked it as the one under which the wolf nursed Romulus and Remus.

As to whether our oldest trees are susceptible of an increased rate of growth by the application of fresh earth around the roots has not been sufficiently tried.

Thomas Meehan, who made a tour of investigation to California and as far north as Alaska, said at the Academy of Natural Science: "There

was nothing phenomenal in the great age of the mammoth Sequoias, as other trees on the Pacific coast exhibited great age."

In order to ascertain if more than one circle is found in a year, he tested the matter in various ways. A pine or spruce would make an average growth of a foot a year up to fifteen years old; from that on, 6 inches; after that a stage was reached where the erect growth ceased to any considerable extent, and the growth force seemed to turn towards the lateral branches. In the pine forests of the Pacific coast there was no danger of error in fixing the age of the average tree of 60 feet high at about fifty years, and the circles or rings in those cut down would be found to correspond so nearly that it was quite safe to assume a single circle for a year. The remarkable uniformity in the diameter of the annual growths would also enable one to tell the age sufficiently accurate for general purposes. Trees growing on very rich soil have less circles to the inch, often as few as four, but six to the inch is quite a safe rule to be governed by of this species. At Harrisburg, in latitude 58°, a Sitka spruce gave 149 rings. This was an average of about 8 to the inch. At Wrangel, in latitude 56° 30′, a Western hemlock gave 18 to the inch. It was 6 feet in diameter at the base. At 132 feet the trunk had been broken off; here it measured 4 feet in diameter. At Kaigan Harbor, latitude 55°, the Sitka spruce is very large and of great height. Two of the largest measured 21 feet in circumference, and he thinks that trees in these latitudes in Alaska would easily have a life of five hundred years.

In the Atlantic States two hundred years is the term of life for its forest trees, with the exception of the plane, which is the longest lived of all. Trees famous for longevity in Europe are comparatively short-lived here. Illustrations can be seen in the Bartram Garden near Philadelphia. The cause of this difference is doubtless owing to the humidity of the atmosphere, for while some species of trees will endure a temperature of 25° below the freezing point in Great Britain, they are killed by 10° in Philadelphia, and it is believed that the dry atmosphere causes a heavy drain of moisture from the trees, making the cold more effective.

The climate of Alaska is similar to that of Great Britain. At Sitka, in latitude 57°, the rainfall was 100 inches in a year, and the harbor rarely frozen over, some winters there being no ice. But, barring accidents, and with soil properties being constantly kept up, the life of a tree is well-nigh without end.

RAPID DESTRUCTION OF THE FORESTS.

The reports of the Agents of the Bureau confirm the Census reports as to the rapidity with which the forests of the country are being destroyed by the axe of the lumberman and the miner, and by forest fires. Corroborative evidence is also furnished by the reports of Boards of Trade and by the statements made from time to time by various periodicals published in the interest of lumber manufacturers. It is presumable that the figures given by these papers and by Boards of Trade are at least approximately correct, and that they do not exaggerate in their statements. There is no reason, it would seem, for their doing so. How much of the consumption of our forests they fail to take account of because the work of the smaller saw-mills or the felling of trees a few at a time in thousands of places is not reported, we do not know. But taking the statistics as we find them, they make an exhibition which is startling.

CENSUS REPORT.

The Census of 1860 does not give the amount of lumber produced at that time, but only its value. This is reported to be $96,715,857.

In 1870 the census reported the lumber product to be 12,755,543,000 feet, board measure, and 3,265,516,000 shingles, having a value of $210,159,327, with 63,928 establishments engaged in the manufacture of articles made entirely of wood, employing 393,383 persons and using material valued at $309,921,403, beside 109,512 establishments in which wood formed an important part of the material used, these employing 700,915 persons and using material valued at $488,530,844.

In 1880 the census returns give as the amount of lumber produced 18,091,356,000 feet, with the addition of 5,555,046,000 shingles. It will be seen that the product of lumber has been increased from decade to decade in a more rapid manner than the population of the country.

If we take the Northwestern States, Michigan, Wisconsin, and Minnesota, now the principal sources of pine-lumber supply of the country, we have the following figures for the decade 1873–'83:

Description.	1873.	1883.
Lumber	3,993,780,000	7,624,789,786
Shingles	2,277,433,550	3,964,756,639

Showing an amount nearly doubled in ten years.

SUPPLY OF LUMBER OUTRUNNING DEMAND.

This rapid increase in the amount of lumber produced, outrunning so far the increase of population and the natural demand for it, shows that the forests are consumed at an unwarrantable rate. This is shown also by the fact that the lumber markets have been reported generally as greatly overstocked and the lumber trade as dull. So extensive had been the cutting of the forests that a large amount of logs were left over at the close of the last year. Appeals were then made by those interested in the trade for a lessened cut of logs last winter, and promises and predictions were made that it would be diminished. So far was this, however, from being the fact, there was a larger cut than ever before. The weather and other conditions proving favorable, the lumber camps carried on their work of destruction in the forests with the utmost vigor, and protracted it as far into the spring season as possible. The destructive disposition seems to find a special provocation or vent for itself in the forests, so that the lumberman pursues his work often beyond the limit which self-interest would assign to it. In the face of an overladen market and unremunerative sales, he will often continue his work with a seemingly reckless disregard of consequences. The profitableness of the lumber business a few years ago incited many to engage in it who possessed but little capital, and who were obliged to purchase their timber land or stumpage at an advanced price and more or less on credit. This class have been under the necessity, certainly under a strong inducement, to convert their standing timber into lumber, and put it upon the market as soon as possible. But others, who had become possessed of timber land at cheaper rates, and who by past success in business were able to suspend or curtail work in the forests, have not chosen to do so. Having the advantage of the former class, in the ability to secure a profit because able to manufacture at less cost of material, they have pursued their advantage.

FORESTS HAZARDOUS PROPERTY—FIRES.

It is to be admitted also that the hazardous nature of forest property, resulting from the prevalence and destructive character of forest fires, offers a strong inducement for the rapid conversion of the trees into lumber. In the timbered regions of the country one can scarcely look around him, especially at certain seasons of the year, without seeing the smoke of burning forests. In some parts of the country these fires are of alarming frequency and extent. It is estimated by competent and trustworthy judges that as great an extent of the forests is consumed by fires as by the axe. If it is so, this class of property cannot be regarded as otherwise than hazardous. It may be said that there are at present no safeguards against forest fires.

The laws hitherto enacted by the different States are of little efficacy. No State is as yet sufficiently awake to the value of this species of property to make adequate laws for its protection, and the owners are not disposed of their own accord to adopt such a course as is needful for their own protection. There is such a community of interest involved in the possession of this kind of property, that a combination of action is requisite for its protection, which is very difficult to secure without legal compulsion. It is of little use for one person to adopt expensive measures of protection unless the same are adopted by those in his neighborhood. If fire breaks out by accident or is kindled by design in a forest near him, it may sweep through his most valuable timber despite all that he may have done for its security. The consequence is that forest property is a very unsafe kind of property. The holders of it live in constant fear that any day, in certain seasons of the year especially, may witness its swift destruction by the flames. One can hardly open the newspapers without reading of some such disaster. As a consequence of this condition of things, few persons are ready to invest their funds in the purchase of timber except with a view to its speedy conversion into lumber, and those who possess timber lands are strongly urged to cut their forests rather than risk their consumption by the flames.

MARKETS OVERSTOCKED.

As the natural result of these various motives of action, the for are consumed much faster than the natural demands of their prod require, and the lumber market is overstocked to such extent that the price of lumber is in some cases below the cost of producing it, and far below what it would naturally be in face of the fact that the source of supply is so rapidly diminishing. And this is a condition of things not peculiar to our own country.

The lumber markets of Great Britain are equally crowded with the produce of the forests, and as a consequence the prices of lumber are very low. Great Britain is comparatively a treeless country, having only about 4 per cent. of her area in wood, Denmark being the only European country having less. Yet such is the supply of lumber crowded upon the English market from the great forests of Norway, Sweden, and Russia, as well as from the Canadian provinces, that complaint is made that her home-grown timber cannot be sold at remunerative prices. So overstocked are the markets that hundreds of British vessels are reported to be laid up at their docks without employment, which have been used formerly in the lumber trade.

A recent number of the Timber Trades Journal, London, England, says:

We have already had occasion to speak of the peculiarity that while our imports generally are decreasing in sympathy with the contraction of trade, the influx of timber goods knows no intermission. On the contrary, it is enlarging on a scale that would be compatible only with something more than an average demand, but is not easily reconciled with an admitted curtailment of business and the small prospect of turning it over at a fair market price.

A later issue of the same journal says:

If it were not for the large public works in progress there would be next door to nothing doing to carry off the large surplus stocks that are continually accumulating. It is the same cry everywhere, business slack and trade seemingly at a standstill. If you speak to any one about buying they will hardly stop to inquire the particulars of the goods you are offering, and even though the arrivals are slackening, it will take a long time before the benefit of the diminished supplies will be felt.

Freights are still low, the ship-owners, as represented by their captains, being apparently at the mercy of those few importers who are still in the market for tonnage.

Again it says:

Several of the sailing ships usually engaged in the carrying of wood goods from the Bothnian Gulf are preparing to lie up, the approaching autumn, premiums for insurance giving their owners no hope whatever of making ends meet in the present state of the freight market.

In a measure the same causes which have led to the rapid consumption of our forests have occasioned a like destruction of the Scandinavian woods, and anxiety has arisen in Norway and Sweden on this account, and the Government of those countries has been urged to adopt measures calculated to prevent the disastrous consequences which are threatened.

REPEATING HISTORY OF OTHER NATIONS.

We are only repeating in this country, in respect to the forests, what has everywhere occurred since the earliest historic periods. Only when the forests have been consumed have men learned their real value and the office which they were designed to fill in the grand economy of nature. As mankind have migrated from the original home of the race, in whatever direction they have gone, their course has been marked by the destruction of the forests. Sometimes these have been destroyed in order to clear the ground for agricultural use, sometimes as a measure of defense or offense in war, sometimes with the simple desire of pecuniary gain, but always with a disregard of the ultimate consequences.

RESULTS OF REMOVAL OF FORESTS.

It is only recently, indeed, that we have learned that the removal of the forests involves anything more than the loss of the forests themselves. Their connection with climate, with the precipitation of moisture, with the flow of streams, with the atmospheric currents, with the temperature of the atmosphere, and consequently with the great interests of civilized life, with agriculture and commerce, was not known—was hardly suspected a little while ago. The forests were valued for fuel, for the production of timber for constructive purposes, and for certain uses in the arts, and as the supply for these purposes seemed sufficient and more than sufficient, no restraint was placed upon their consumption. But at length it has been discovered that the forests have meteorological connections of the highest importance. It has been discovered that their extensive removal is the occasion of droughts and floods, of tornadoes and destructive torrents. The change in the condition of many countries of the Old World, so that from once being

gardens of fertility they have become little better than desert wastes, has been clearly traced as to its cause—to the destruction of their forests, at once their adornment and their defense. It has been hoped that these discoveries, the result of scientific and painstaking observation mostly within the present century, would save us from experiencing the sore evils which have befallen many other countries, by inducing us to adopt such timely and effective measures as would lead to the husbanding of our forest resources and the preservation of that balance of natural conditions upon which our future national welfare and comfort are so dependent. Whether this will be the happy effect remains to be seen. In this new and rapidly-developing country the legitimate—we may say the necessary—demands upon the forests for fuel and for lumber of course are great. Our people are not accustomed either to have the use of their property controlled by Governmental regulations or restrictions as are the people of the Old World. The interests which the people at large have in the forests, irrespective of their ownership, is not generally—is not to any considerable extent—understood. The owners of the forests for the most part look upon them simply from the pecuniary point of view. The lumberman sees in the trees only the source of so much money, and hastens to secure it. Lumber brings so many dollars a thousand feet, and he hastens to convert the monarchs of the wood into available merchandise. He cares nothing, knows nothing, of meteorological effects. He will not learn that in cutting down the forests which border the streams he is destroying those streams, until he finds they will no longer float his logs to the saw-mills, probably not even then. Nor does he care if only he can get his lumber into market and convert it into money. If the market is glutted this year so that sales are dull and prices low, he will hope that his neighbors will lessen their cut for the next season, and so there will be sufficient reason for him to continue his business unchecked. Meantime his neighbors hope and reason in the same way in regard to himself, and so all continue to cut to the greatest extent, and the glut in the market is kept up. The producers are not benefited, but the trees are destroyed and the future welfare of the country is threatened.

DESTRUCTION UNRESTRICTED.

Even in the face of this overproduction and the great areas already stripped or nearly stripped of their forests, those who look at the matter without any pecuniary interest and call attention to the threatened danger, are stigmatized not unfrequently as alarmists, and we are assured that we need not concern ourselves about the lumber supply. We are also told, notwithstanding the proofs established by the most careful and protracted examination of the subject by most competent observers in Europe, that the removal of the forests has nothing to do with the flow of streams or of droughts and floods, and so is of no importance in connection with our commercial interests. At the same time it will be found that the lumber manufacturers themselves are perfectly aware that at the present rate of consumption the great forest regions of the country will soon be exhausted. The lumber-trade publications, when addressing themselves to the lumber producers and tradesmen in distinction from the general public, frequently declare that the supply of growing timber is becoming scanty, and urge that the cut of logs should be restricted on this account as well as to bring about a better state of the market, and conventions of lumbermen are held for the purpose of securing an agreement among them to send smaller gangs of men into the woods in

winter and to suspend the operations of the saw-mills for a certain portion of the milling season. But it seems impossible to secure such an agreement. Personal greed and personal necessity appear to be too strong to be overcome by any consideration of general or remote advantage, and the work of destroying our forests seems likely to go on with constantly increasing rapidity until we suffer, not only from the scarcity of lumber, which is so important, not to say indispensable, for so many of the arts and industries of civilized life, but, as the result of stripping the forest-covering from the hill-sides and from the borders of our streams, we bring upon ourselves floods and droughts and other evils more severe than we have yet known.

European countries have been engaged, some of them for a century or more, in efforts to check the evil consequences which have followed the destruction of their forests and to restore, if possible, the condition of things which existed before that destruction took place. It is a tedious and costly work. Great expenditures of money have been necessary, and only by slow degrees have those countries been even partially reclaimed, and it is only by the constant intervention and exercise of the Governmental authority that the improvement secured from time to time is maintained and that the former destructive operations are not resumed, and the people again threatened with the calamities from which they formerly suffered.

NEED OF GOVERNMENT ACTION.

Since, therefore, the considerations of individual self-interest are not, as they never have been, sufficient to regulate this matter, there is all the more reason for the action of the Government in regard to the subject. In proportion as, in the freedom of individual action, less restrained here than it is in European countries, many are engaged in destroying the forests which are the property of private owners, ought the Government to act promptly and efficiently for the preservation of the forests which still belong to the nation. These are now being wasted. For a long time they have been regarded as lawful plunder, and unscrupulous persons have enriched themselves by cutting the trees and disposing of them in the market or using them for their private purposes. Hundreds of miles of Mexican railway, it is said, were constructed of ties cut on the public lands of Arizona, for which no permission was granted and no payment received. The Government has been very lenient in its treatment of these despoilers, as it has been liberal also in permitting settlers in the vicinity of its forests to make use of them for their actual needs. This liberality has been taken advantage of unwarrantably. The time has come for the Government to adopt a different course of action from that which has hitherto characterized it. While it may still be liberal, it should also be just to itself and to the country. The forests are a trust which the Government holds for the general benefit. It has no right to allow them to be squandered or to suffer their value to be lessened by individual encroachments. It should be as prompt to arrest and punish the theft of its timber as to arrest and punish the one who violates its revenue laws. A fraudulent entry at the land office ought to be visited with punishment as swiftly and as surely as a fraudulent entry at the custom-house. In our wide domain there is no such demand for land for agricultural purposes as makes it necessary to dispose of any of our timber lands that they may be deprived of their forest-covering and so prepared for tillage. The prairie and other arable lands now open for sale, and the timber lands of private

owners from which the trees have been swept or from which they are being rapidly taken, will furnish for a long time to come all the fields needed for the uses of agriculture. The timber lands yet remaining as the property of the Government are needed for a use that combines with agricultural prosperity many other important interests.

PROTECTION OF RIVERS BY FORESTS.

It has been ascertained beyond question that the flow of streams is dependent upon the extent of the forests in their vicinity. Where these abound the flow is comparatively uniform as to the supply of water. This is of great importance, both to agriculture, commerce, and manufactures. In the absence of forests the streams are subject to great variations in their volume. Now they flow along their course in great and disastrous floods, and now again shrink away in their channels or almost disappear. The difference of a few feet in the depth of water in a river may make the difference between a stream under control and one that has become a source of widespread disaster. It is only the difference of a few feet in depth which converts the Mississippi from a great and beneficent artery of commerce to a sea of water carrying destruction to crops and producing suffering which requires millions for its relief. That difference may easily be produced by the presence or absence of forests, especially on the headwaters of that stream and of its tributaries. The Government is called upon from time to time to contribute liberally for the relief of those who are suffering from the overflow of the great river of the West, and to expend millions in building embankments for the purpose of restraining the angry waters which come pouring down from the Rocky Mountains on the one hand and from the Alleghanies on the other. It is only with great difficulty that these embankments are maintained, and from time to time they are burst asunder by the flood and have to be rebuilt.

FORESTRY BETTER THAN DIKES.

If the forests along this stream and its affluents had not been removed the floods would seldom have reached a dangerous point, and the true remedy for them now is the establishment of forests along the upper water-courses, rather than the building of dikes on the lower portions of the stream. These are but a temporary and ineffective remedy at the best, and attended with great and constant expense. The former, once established, would be an abiding protection, and also a lasting source of revenue. With the aid of the forests, we may say without hesitation that our great navigable waters, not less than the smaller streams, are completely within our control. Observation and experience in European countries, reaching through a long course of years, have shown this to be so. Large masses of forest in the vicinity of rivers perform to a great extent the office of reservoirs or reserve basins in which the waters are stored up when over-abundant and from which they are discharged when needed, thus preserving an equable flow. In a region destitute of forests, the falling rains or the rapidly melting snows find their way at once to the nearest river channels and fill them often beyond their capacity, causing, it may be, a disastrous overflow. But where masses of woods are present the waters make their way more slowly into the river channels, and consequently pass away gradually without overtasking those channels or causing harmful floods. This effect of forests has been very strikingly shown in France

in the case of two streams whose basins are situated very near each other, one of which is well wooded, while from the other the forest-covering has been removed. The case is so interesting as to warrant quoting an account of it from the *Revue des Eaux et Forêts:*

The state possesses, in the department of Vaucluse (writes the forest conservator La Buissière), a forest of more than 3,000 hectares, situated on the portion of the mountain Luberon, nearest to the valley of the Durance. This region is very much cut up, and traversed in all directions by very narrow and deeply embanked ravines in the midst of masses more or less dense of Aleppo pines and green oaks.

These ravines are almost the only outlets for the transport of wood, in consequence of the difficulties which would be encountered and the expense which would be incurred in making more practicable ones on the rapid declivities strewn with enormous masses of rock. There exists one so situated, called the Ravine de Saint-Phalez. The direction is from north to south, in the midst of a mass of Aleppo pines in a state of growth more or less compact.

Its length, and for 4 kilometers, or from the road from Cavaillon to Pertuis, to the domain of Saint-Phalez, of an area of about 50 hectares, forms the *bassin de reception* of the torrent.

This land is well cultivated; there are no declivities too steep for cultivation; it comprises vineyards, meadows, and arable land; the soil is argillaceous.

The ravine of Saint-Phalez receives many affluents, the most important of which is that of the Combe d'Yeuse, which joins it near the summit, where are some hundred meters of the cultivated grounds of which I have spoken.

The ravine de la Combe d'Yeuse is of much less considerable length than that of Saint-Phalez; it is scarcely two kilometers. It is strongly embanked, surmounted by deep declivities, covered with green oaks of eight or ten years' growth, and the Aleppo pines of different ages. Its *bassin de réception*, of about 50 hectares, or 123 acres, comprises the whole slope, precipitately inclined, with a general southwest aspect. It is closed at the top by a deep bed of rock cut into peaks of the most imposing aspect.

The geological formation in both is absolutely the same, as are all the other conditions at all the points which I have examined.

In no part is to be seen either spring or appearance of humidity. No water is seen excepting at the times of storms or great rains, and this water soon passes away, with the differences which will afterwards be mentioned. At all other times these ravines are of a desolating aridity.

In the night of the 2d or 3d of September, 1864, there fell a rather abundant rain over all this portion of the mountain. In the morning the argillaceous grounds of Saint-Phalez were saturated, of which evidence was found by any one attempting to cross them. The ravine of Saint-Phalez, the receptacle of the surplus water, had flowed but slightly; that of the Combe d'Yeuse remained dry.

The day of the 4th of September was warm; a water-spout borne along by a southwest wind struck on the Luberon. Its passage did not last more than forty minutes; but scarcely had it come when the torrent of Saint-Phalez became awful. Its maximum deliverance was about 2 cubic meters. It did not flow more than fifty minutes, but with an average delivery of a cubic meter; it had then passed in all 15,000 meters of water. Its height had been 0.04 m.; each square meter had received 40 liters, and the 50 hectares of Saint-Phalez 20,000 cubic meters. The ground had only retained 5,000, which is sufficiently explained by its argillaceous character and the state of saturation the night before. While the torrent of Saint-Phalez flowed, filled from bank to bank, seizing and carrying off rocks which had been employed to form a road which was believed to be safe against all contingencies, that of the Combe d'Yeuse and all those traversing the wooded lands remained dry, or gave only an insignificant quantity of water.

On the slope opposite to that of which I have been speaking, in the valley of Peyne, a carriage road newly formed did not experience the least injury throughout the whole of the portion of it passing through the forest of the domain; but at its issue, on the lands of the Libande and of the Roquette, it had been, so to say, destroyed. A cart loaded with fagots was upset and smashed by the waters, which flowed from all the cultivated slopes, and tore along, with the noise of thunder, at the bottom of the ravine.

My good fortune secured to me another subject of study on the same ground.

On the 25th of October following I went to the sale of the fellings of the Tarascon, where there fell an abundant rain. The next day, the 26th, the weather was clouded. I set off for the Luberon in the hope of arriving there at the same time as would a storm of rain, which I saw approaching. I arrived first; the ravine of Saint-Phalez was still moist from the passage in small quantity of the waters of the night before; they had served, as appeared, to saturate the lands of the domain, as had previously happened on the 7th (3d?) of September.

I had scarcely gone over two kilometers in the ravine when the water began to rush with great violence; ten minutes later it precipitated itself in its ordinary *canal d'ecoulement*, completing the work of destruction begun in the month of September. The lands of Saint-Phalez had absorbed but little or none of the water that day.

The storm was not of long duration, an hour at most. The time was unfavorable for collecting on the ground exact measurements, but I reckon that the torrent delivered, at its maximum, somewhat less water, perhaps, than on the 4th of September. The flood, however, was more frightful; it swept away rocks with so much the greater ease that nothing had been repaired since the first storm, which had left the stones dug out, and without bond of cohesion among themselves.

To gain the forester's house, which was on the slope of the left bank, it was necessary to make a long circuit, to go round the domain of Saint-Phalez and to cross the grounds belonging to it, in which one sank to the depth of 0.30 meters, or 12 inches. Before arriving at my home, I still had the ravine of the Combe d'Yeuse, and I feared I would be stopped there by a new obstacle. I was agreeably surprised to find it dry. An hour after the storm the ravine of Saint-Phalez had ceased to flow.

It rained throughout the whole of the 28th, without there being anything to remark similar to what had happened on the preceding days. The only effect of this was that on the evening of the 30th, near the forester's house, and at 200 or 300 meters from the ravine of Saint-Phalez, there was seen coming down, in that of Yeuse, a small fillet of clear water. Its volume increased perceptibly during the three days, to diminish in like manner during the two which followed. Its passage broke down a little of the foot-path which goes along the valley, but caused only a damage easily repaired. But this foot-path presented nothing of the solidity of structure of that of the Combe de Saint-Phalez, built on enormous blocks of rocks, which had stood for several years, and which had allowed of passage with a wagon some days before its destruction by the storm in September. If the Combe d'Yeuse had yielded as much water as that of Phalez, and if these two masses of water had come at the same time, the damage caused in the plain must have been considerable, and the Durance, which received these waters, would have been so much the larger.

Thus we have two torrents very near and under the same conditions, except that the basin drained by the one comprises 50 hectares of cultivated lands, that of the other 250 hectares of woodlands. The first receives, and allows to flow away, the waters of the greater part of the storm, in a few hours at most, causing thereby considerable damage; the second, which had received a greater quantity of rain, stores it, keeps it for two days, evidently retaining a portion of it, and takes three or four days to yield up the surplus, which it does in the form of a limpid and inoffensive stream.

GOVERNMENT AID IN REFORESTING STREAMS.

The importance of preserving a forest growth in the vicinity of streams appears, therefore, to be very great; it is our natural safeguards against both floods and droughts. There should be no hesitation or delay, therefore, in protecting from injury such of our remaining public forests as are so situated as to exercise this conservative influence upon streams. It is one of the clearest duties of the Government so to protect them. The most stringent provisions of law should guard them from depredation or injury, and in no case should the title to them be alienated by the Government. They should remain under the public management as one of the sources of national benefit. In addition to this, efforts should be made by the Government to clothe again with trees portions of the country in the neighborhood of streams from which the forests have been cut off. It cannot be expected that such a work will be undertaken by individuals. The work required is too great and costly, and there is no adequate motive to engage in such an enterprise. Tree-planting by individuals will only be undertaken when there is a reasonable assurance of pecuniary advantage, and it will be quite limited in extent. Nor will it be practicable to obtain such a combination of individual action as to secure the desired result. Neither, again, can it be expected that the separate States will engage in such a work with the requisite efficiency. A State might well undertake to protect streams of such limited extent as to be contained within its own borders. But many of our streams pass through or form the bounda-

ries of several States. Six or seven States are affected by the floods of the Ohio. Indiana is more likely to be damaged by them than is West Virginia, but the most efficient protection against them is to be made in the latter State rather than in the former. Yet it would be difficult to engage Indiana in establishing protective forests in West Virginia or to induce the latter State to plant forests for the benefit of Indiana.

A FOREST COMMISSION.

The only way of securing the end desired, therefore, seems to be by the action of the General Government. The passage by Congress of such a bill as that introduced at the last session by Senator Sherman, constituting a Forestry Commission for the purpose of ascertaining the forest condition of the country in the vicinity of navigable streams, would be an important step in the right direction. The bill of Mr. Edmunds is one of similar character and ought not to fail. It may well be asked also why the General Government may not as well appropriate money, in conjunction with the States most interested, for the purpose of preventing floods in the Ohio and Mississippi, those great arteries of commerce, by reclothing their upper waters with forests, as to expend millions in building dikes to check the ravages of the floods.

For many years France has been engaged in stopping the ravages of torrents by replanting the mountain sides with trees. These torrents had been growing more destructive from year to year, as the forests were cut down by the peasantry, chiefly for the sake of extending their pasture grounds. Great masses of rock and gravel were swept down the mountain sides from time to time into the valleys and plains below. To such an extent did this destructive process go that the cultivated lands of whole villages and districts were in some cases overspread with the *débris* brought down by the torrents, and the inhabitants were compelled to abandon their homes and fields and remove to other portions of the country in order to continue to gain a livelihood by agriculture. Aroused by these desolating calamities, the Government instituted an inquiry into the cause and the proper remedy for the evil. After a careful investigation of the subject, conducted in a most scientific manner, the Government undertook to check the devastations of the torrents by restoring their woody covering to the mountain slopes, and by regulating the cutting of their forests by the proprietors. Wherever it was deemed necessary that there should be trees for protection, the proprietors were directed to replant their denuded acres. If circumstances required it, they were assisted by the State, to the extent of furnishing them with seeds or young trees fit for planting. If with this help the proprietors declined to comply with the demand to replant, the State asserted its right of eminent domain, took possession of the needed land and planted the requisite trees, leaving the proprietors still the right of redeeming their lands within a certain period, on condition of paying to the State the expense which it had incurred in the work of reforesting. This work of reforesting, so far as it has gone, has been entirely successful. Wherever it has been carried out the ravages of the torrents have been checked, and it has been abundantly proved that the forests are an instrument by means of which torrents and floods can be controlled, and that if man can mar the face of nature by his heedlessness or reckless selfishness he can also heal the wounds which he has made.

In some such way as that adopted by France and other European nations must the General Government of this country meet the problem

now before it, of the protection of its navigable streams by means of the forests. In doing this it will at the same time accomplish other results of great importance. It will meliorate the climate of the country, rendering it more salubrious to man and beasts and more favorable to agricultural pursuits. The streams, made thus more equable in their flow, will be greatly improved as the channels of commerce and as a source of steady power for the various mechanical and manufacturing industries of the country.

PROTECTION OF GOVERNMENT FORESTS.

The fact that the timber-lands in possession of private persons are being rapidly destroyed, so that the visible supply of lumber is reduced to very scanty dimensions, while scarcely any provision is made for its restoration by planting or by measures calculated to secure its reproduction by natural means, renders it the more imperative that the Government should at least protect and make the most of its own forests. It seems a vain hope that private proprietors will treat their woodland property in a conservative way or have in its management any regard for the general welfare or any other consideration than that of personal pecuniary profit. The prevailing disposition is to convert the tree into lumber in the speediest manner. The result is that more lumber is thrown upon the market than the country wants, consequently prices go down in the competition of sellers with each other until in cases, not a few, lumber is sold for less than the cost of its production. Recently a meeting of the lumber manufacturers of the Northwest was held at Chicago for the purpose of consultation on the depressed condition of the lumber trade. The meeting was a large and influential one, consisting of mill-owners and forest-owners from all parts of the great pine timber territory of the Northwest. It was said to represent a capital of $500,000,000. The endeavor was made to establish an agreement among the mill-owners to suspend the operation of their saw-mills at a given date, a few weeks earlier than the usual time of suspension, and thus to lessen the oversupply of lumber. It was admitted by all that the production of lumber in the Northwest at present is in excess of the demand by 1,500,000,000 feet, and that if this amount could be withheld from market the amount left would sell for as much as would be realized from the whole stock offered for sale or likely to be, and the amount so withheld would represent so much timber preserved and so much pecuniary profit. But no agreement to restrict the manufacture could be effected. The most that could be attained was the passage of a resolution recommending restriction, but leaving it to each one's sense of self-interest to comply with the recommendation or not. It was confessed by this company of men that any restraint upon individual action other than individual personal interest was impossible; that the trees would be felled, converted into lumber, and put upon the market so long as a pine tree was left of the forests.

The appeal, therefore, to individual action for the conservation of the forests seems hopeless and makes the action of the Government the more important and urgent. And if the Government is to act in this matter, it is wise policy for it to act promptly and with all possible efficiency. Dilatory action and inefficient measures allow the evils to be remedied to reach larger proportions than they have now, and necessitate greater and more costly efforts on the part of the Government hereafter. In taking such action as has been indicated we shall be but opting the course recommended by common sense and the course

which the experience and the mature consideration of other countries have led them to adopt.

FORESTRY, BECOME SCIENTIFIC.

As certainly as the conclusions of science and patient observation are to be trusted the system of forest conservation and management which has been adopted by most of the European Governments is the one which, in its substance and essential elements, must be accepted and pursued by us. And the sooner we recognize this fact and act upon it the better. There is no American method of forestry in distinction from a European or an Asiatic system. The great laws of nature are the same in all parts of the world. The laws of vegetable physiology are everywhere the same. Varying combinations of soil and climate may require some corresponding variations of treatment in the cultivation of trees and in the management of forests. But the general system must be the same, governed by the same general and unchangeable laws.

We know, therefore, the main course to be pursued. We enter upon it in no uncertainty as to its wisdom or the results to be gained. Others have been experimenting for us through a long course of years, and it is our privilege to have the benefit of their experience at the outset of our work. Forestry is no longer a matter of experiment, though it offers all the while an ample field for experiments. It is now an established science, and carries with it the certainty of science in securing results. We can grow a forest as well as we can a field of corn, and with the same certainty as to the product. The same adaptation of science which has raised the work of the husbandman from the haphazard condition of ignorance to the dignity of an intelligent process and to the value of an employment having an assured success, when applied to the management of trees in masses, renders it not only one of the most interesting but one of the noblest and most valuable pursuits in which men can engage.

OBJECT OF FORESTRY NOT TO RESTRICT USE OF THE TREES.

The object of forestry is not, as many perhaps suppose, the mere preservation of timber-trees, whether from the ravages of fire or the axe. It is not to withhold them from being converted into lumber for the many uses of civilized life, or from supplying the equally pressing demands for fuel for domestic and manufacturing purposes. On the contrary, an intelligent system of forestry, while it seeks to protect the forests from needless consumption or harm, undertakes so to cultivate and manage them as to secure the largest possible supply of lumber, fuel, and other products, while at the same time preserving the forest capital as a whole in its integrity and undiminished in value. It undertakes to secure these direct material advantages in the greatest degree, while securing at the same time climatic and other results of the utmost importance. There has been a great misunderstanding on this subject. Many have been led to suppose that those putting forward the claims of forestry were advocating a policy which would infringe the rights of property by limiting or restricting the freedom of the individual as to the cutting and disposal of his forests. When the preservation of the great Adirondack forests has been advocated, the impression has been made upon many persons that a great source of valuable lumber was to be withheld from the public, the trees to be left to grow and at last decay

without having contributed anything to the public wealth or welfare. In consequence of this it has been easy for those who are profiting by the plunder of the forests to create an unintelligent opposition which has hitherto prevented any effective measures being taken for the proper and conservative management of the Adirondack region. Such management would not withdraw that region and its forests from the public or lessen the value of its products, but it would increase them. It would preserve that region for the public. It would in due time increase its lumber products to an amount far beyond its present yield. It would protect it from devastating fires. It would preserve it as a great sanitarium or health resort, making it more accessible than now by means of improved roads, while still preserving all the charms of its natural wildness. At the same time it would exert an important climatic influence upon the country, and have a most valuable effect in preserving and rendering equable the flow of that great channel of commerce, the Hudson River. Figures cannot represent the beneficial results which might thus be obtained.

This is but a single illustration of the proper character and work of scientific forestry. What it would do in the case of the Adirondacks, it would do substantially in other cases. Everywhere it would be conservative, in the best sense, both of the pecuniary and other interests of the people. Its results would be good and only good in every sense.

WHY GOVERNMENTS SHOULD ENGAGE IN FORESTRY.

It deserves encouragement, therefore, on every hand, and from the private citizen as well as from the Government. It is especially a fit work to be fostered and undertaken by the State and General Governments. The work of forestry is one of such a protracted nature, reaching continuously through such long spaces of time, demanding the lapse of so many years often for the accomplishment of some of its objects, that individuals shrink from the undertaking through the apprehension that they may not live to see the expected or promised results. But the life of a State is unlimited. A State is not discouraged because its work needs long time for its completion and the full accomplishment of the object aimed at. While, therefore, there are reasons sufficient to warrant individuals to engage in the work of forestry, it is a work peculiarly appropriate to governments. Every consideration of national welfare urges them to engage in it. As a source of revenue it is one of the surest and most constant. There is none less fluctuating. As an element of general prosperity there is none more important. It is closely connected with the manifold industries of life. History shows us that nations have declined in power and prosperity with the decline of their forests. It will be our wisdom to profit by the lessons of history and to spare ourselves the sufferings with which other nations have been afflicted, by arresting the destruction of our forests before it has reached a point beyond remedy.

The bill introduced into the Senate at its last session by Senator Edmunds, and having for its object the reservation of a considerable tract of land in Montana, on the headwaters of the Missouri and Columbia Rivers, was a step taken in the right direction. Having passed the Senate it awaits the action of the House of Representatives. Another bill of like character but more general scope was introduced in the Senate at its last session by Senator Sherman. It provides for a Commission for the examination of the subject of the preservation and cultivation of

woods and forests adjoining the sources of the navigable rivers and their affluents, and increasing their extent by planting trees along the courses of the said rivers where the land is timberless, so that the said rivers may be kept in a navigable condition by promoting a continuous supply from their sources and affluents. The commission are to make annual reports to Congress of the result of their examinations.

This bill, or one of similar character, is the proper beginning of any systematic and efficient work on the part of the Government for the preservation and management of our forests, and it is to be hoped that nothing will delay its speedily taking the form of law. We need a careful survey of our forests in order to determine to what extent their continued preservation is essential to the general welfare, and to what extent they need to be supplemented by plantations of trees where there are none.

THE FORESTRY CONGRESS.

In the month of May last the American Forestry Congress, by invitation, held a special meeting at the Department. At this meeting, in connection with its appropriate business, several papers were read which treated upon the value and management of the public timber-lands, the influence of forests upon the headwaters of streams, and the distribution of trees in North America. These papers have since been published by the Department as being helpful to the forestry work in which it is engaged through this Bureau, and have been widely distributed through the country. There is reason to think that they will be of important service in conveying information and enlightening public opinion upon the subjects treated by them.

EDINBURGH INTERNATIONAL FORESTRY EXHIBITION.

The International Forestry Exhibition has been held at Edinburgh, Scotland, during the present summer, in which this country was invited to participate. As we have no scientific schools of forestry, such as abound in most foreign countries, and particularly in Europe, nor any considerable collections of forest products, we were not in a condition, if so disposed, to make any important contributions to the exhibition. It was hardly possible for the Department to be represented in its forestry work. The following report of the exhibition, however, is presented by Professor Riley, the Entomologist, who visited the exhibition under instructions from the Commissioner of Agriculture:

For the inception of this exhibition credit is due to the Scottish Arboricultural Society, and one of its principal objects was to direct public attention to the necessity which exists in Great Britain for the establishment of a school of forestry after the model of those existing in France, Germany, and most other European countries. The apathy of the British Government in respect to such a school is the more remarkable considering that Great Britain possesses, to a larger extent than any other country, forests in every quarter of the globe.

The classes into which the exhibits were divided were nine in number, viz: Practical forestry, forestry products, scientific forestry, ornamental forestry, paintings, drawings, and photographs of forest subjects, forest literature, essays and reports, economic forestry, and the loan collection.

About fifty foreign Governments and over five hundred private exhibitors applied for space, so that an infinite variety of articles connected directly or indirectly with woods and forests were laid out for the inspection of visitors.

The fifty foreign Governments, it should be explained, included the local governments of British colonies, not a few of which were represented. In proceeding to give a few descriptive notes of the collection we begin with the

BRITISH COMMISSIONERS OF WOODS AND FORESTS EXHIBITS.

It may help to explain the apathy of the British Government on the subject of the conservation of forests when it is mentioned that of all the splendid royal forests which were to be found in different parts of the country, in which many a merry monarch followed the chase, only 53,000 acres remain. These are distributed as follows: Dean Forest and High Meadow Woods, Gloucestershire, about 19,500; Windsor Forest, 10,000; New Forest, Hampshire, 18,750; Bere Woods, Hampshire, 1,434; Alice Holt, Hampshire, 1,887; Woolmer Forest, Hampshire, 870; Parkhurst, Isle of Wight, 1,152 acres. Epping Forest, the well-known play-ground of the Londoner at holiday times, is the property of the corporation of London. From the last-mentioned forest the conservator, Captain Mackenzie, sent numerous specimens of nature's freaks, in the curious self-grafting of branches, of the interlacing of roots, and peculiar contortions of trunks. Admirable plans of forest lodges were also shown. The "Burnham Beeches," a magnificent group of trees in Epping Forest, which have been extolled by many writers on sylvan scenery, were represented by photographs and by sections of the wood of some of their number which had been blown down by heavy gales.

In the royal forests oak is chiefly cultivated for use in the royal navy, but other trees are also intermixed, including the ash, birch, beech, and Spanish chestnut, the elm, the lime, the hornbeam, and several members of the pine and fir family. Sections of trees in age from ten to two hundred years were shown, indicating the varying growth of timber under different circumstances and different soils. These timbers give an opportunity of testing the popular theory that the age of trees can be exactly determined by the counting of the ring growths, each ring growth being supposed to represent one year's life of a tree. It appears to be the opinion generally of foresters in Britain that the ring growths may be relied upon to determine the age of a tree, and in some of the trees whose ages are otherwise determinable the ring growths closely correspond to the number of years in which the tree has been in the ground. In the case of some of the old trees, the outer rings become so contracted, indicating the exhaustion of the soil in which the tree had stood, that it was almost impossible to count them with any accuracy. On a chart from the Dean Forest were some very instructive figures, giving the results of experiments carried on for the last hundred years in connection with the planting of oak. These show no opposition to the old received theory that an oak, like every other tree artificially cultivated, is better to be transplanted once or twice before being finally deposited on the spot on which it is intended it should grow. In Britain nurserymen always, in transplanting a tree, trim the tap root so as to encourage the growth of fibers. As illustrating the methods of inclosure in use at New Forest there was set up in the open ground a hoop-iron fence for large areas, which was stated to cost with bank and ditch 1*s.* 1½*d.* per yard; and there was a cleft oak paling shown which can be provided at 1*s.* 1*d.* per yard.

THE QUEEN'S EXHIBITS.

In the open ground was shown a pretty rustic chalet sent by Her Majesty the Queen, and composed entirely of the wood of *Pinus sylvestris*, forests of which tree at one time covered a large area of the Highlands. Some years ago the remains of the old forests of Upper Deeside, where Her Majesty's Highland residence of Balmoral is, were threatened with extinction. They had passed into the hands of a wood merchant, but Her Majesty interposed and bought up the woods, which have been closely conserved since. Her Majesty's private forests on Upper Deeside extend to about 20,000 acres, and contain many noble specimens of the old pine of the country. One massive section of wood from Ballochbirie Forest—one of the Highland forests of *Pinus sylvestris*—is two hundred and seventy years old; another is two hundred and twelve years. The latter had been blown down and had lain on the ground for upwards of forty years, until the sapwood had become wasted into a soil on which are growing heather and cranberry bushes and mosses; but the heartwood, which measures 3½ feet across—from its indestructible nature—is still perfectly sound. The object which Her Majesty had in sending this exhibit was to show how adaptable the *Pinus sylvestris*, being indigenous to the Highlands, is for planting the mountain-sides and valleys of Scotland. The wood is exceedingly valuable, combining as it does great durability with beauty, and can be used for rough work or interior ornamentation. The specimens of the wood, polished, shown by Her Majesty, were of the most beautiful description.

THE BRITISH WAR DEPARTMENT.

This department of the Government service sent a case of the woods used in the royal arsenal, such as oak, teak, ash, mahogany, walnut, &c., for making lances, rifle-stocks, and ordnance wagons, &c., also specimens of the wood used in making charcoal for gunpowder.

SCOTTISH ARBORICULTURAL SOCIETY.

The members of the Scottish Arboricultural Society to the number of 50 or 60 were exhibitors, and being gathered together into one place and neatly arranged the numerous articles which they showed were an important part of the general collection. These included such exhibits as forest tools and implements, a new dendrometer, models of rustic bridges for forest purposes; methods of lining river banks with timber to prevent erosion, and models of transplanting machines of more or less utility. One of the curiosities shown was a table made by Mr. D. F. Mackenzie, Moreton Hall, consisting of 10,000 pieces of 117 varieties of wood grown on the Murthly estate, Pershire. Of more practical importance were contrasted specimens of Scotch-grown and foreign woods used as railroad sleepers. In 1877 some silver fir (*Albies pectinata*) sleepers were laid down on the Caledonian Railway alongside of others made of Baltic timber. On being lifted last June the Scotch silver fir ones were found perfectly sound, whereas those of the Baltic were quite worn out. The collection further included many examples of the ravages of disease in various trees, sections of wood showing damage done by squirrels and various boring insects. The only specimens of living insects which destroy trees were five examples of a giant sirex, both in its natural and larval state—the latter being seen at work tunneling through a log of *Cedrus Libani*. The operations of these creatures—which it should be said were sent from Cheshire—were watched with interest for a few days, but confinement under a glass shade did not seem to suit them, and they died.

BRITISH GUIANA.

One of the most interesting sections was that from British Guiana, a colony whose splendid timber resources are apparently as yet but little understood by the home Government. The executive hope that one of the results of the Edinburgh exhibition will be to call attention to this colony and its resources in a way which has never been done before. The primeval forests of this South American colony are of great extent, and lying along (as they do) the courses of the four great rivers—the Corentyn, the Demerara, the Berbice, and the Essequibo—they may be tapped with comparative ease, and timber transported in an equally cheap manner to the sea-coast for shipment. The famous Greenheart—so useful in ship and dock building—is one of the chief trees; where one of the monarchs of the forests is *Mora gigantea*, which sometimes rivals the California redwoods in height and girth. Specimens of 105 to 110 trees abounding in the colony were comprised in the collection, most of these proving most valuable timber. It may be mentioned that the wood was brought over to this country in a rough state, and when cutting it up for exhibition purposes the workmen declared they had never had to deal with such hard timber in their life. Its effect on their ordinary tools was most marked. Considerable quantities are cut every year in the South American forests for exportation, but so free is the growth that as yet nature has had no difficulty in filling up the gaps thus made. To check waste, however, on each of the rivers a superintendent has been appointed, and the legislature have it in contemplation to establish a forest school and amend the laws so as to obtain more control over the forests than is at present possessed. Greenheart is the chief timber exported, and the temptation to cut down immature trees growing in accessible situations rather than go further into the forest to select full grown timber is great. The specific gravity of greenheart is about 75 pounds to the cubic foot, and its power of resisting the attack of marine worms has been amply demonstrated. One log was shown which had been under water for 100 years, and was as sound as the day it was put in. Many beautiful specimens of cedar wood were shown, and a fine table-top into which 48 specimens of different woods had been worked showed the richness of the colony in timber adapted for furniture and ornamental purposes. For brewing purposes, splendid vats and tuns were shown made of *Walaba* and *Purpleheart*. There is a large collection of the extraordinary fungi of the Guianan forests, which have not yet been studied by any botanist, and there is also an important exhibit of fibers and fiber-producing plants and of medicinal barks. A very popular part of the British Guiana collection were the models of the huts of the Indians who inhabit the head-waters of the rivers, and of curious articles of their manufacture. The forest products shown were also rich and varied. Striking among these was a group of large and curiously-shaped blocks of *Gum animi* from the locust tree, *Hymenœa courbarel*. They were for the most part of a beautiful amber color, and resemble stalactites. Their origin is peculiar. When its pith gets injured by insects, or otherwise begins to decay, the locust tree sheds resinous tears into the cavity thus formed—many of the pieces of gum having the shape of cyclopean tear-drops. The accumulation goes on increasing year by year, and when the tree dies and is cut or blown down, the *Gum animi* is found in the interior. It is much sought after for making the finer kinds of carriage varnish, and is said—such is its scarcity—to be worth £200 per ton.

The India-rubber tree (*Ficus elastica*) also abounds in the colony, and specimens of India rubber and of gutta-percha were shown. The tree seeds shown were of the most diversified character. Two only may be mentioned. One of these, that of the aresawroo (botanical name unknown), when rubbed down and mixed with an unguent, is considered an infallible cure for ringworm and itch, and is in use amongst the Indians; while another, called the snake nut, is a great natural curiosity. When broken there is to be seen by way of kernel of the nut, the germ of the tree, coiled up like the reptile from which the tree in consequence takes its name. The zoology of the forests of Guiana was well represented. Indeed, from British Guiana came a larger collection of forest animals and insects than from any other country. Among other spiders shown was the huge Mygale, which spins a dense white web, and in it captures not only flies and insects but the smaller birds. There was a wasp's nest 2 feet long and 1 foot in breadth, and some formidable looking scorpions and centipedes. There was a large collection of snakes, mostly preserved in spirits, among others shown being the anaconda, or water-boa, which attains a length of 40 feet, and may be said to be the "sea-serpent" of science. It swims in the rivers or lurks on their banks, ready to seize and crush in its ample folds whatever animal may come to drink. There was also a fine example of the great Iguana, a creature like nothing so much as the fiery dragon of heraldry.

ST. VINCENT AND TOBAGO.

From the first named of these islands were many things to show how rich it is in fruit-bearing trees. Prominence was given to the fruit of the cacao from which chocolate is made, a shrub which it appears is largely taking the place of the sugar-cane, on account of the ease with which it can be cultivated. St. Vincent is also rich in fibrous plants. A specimen of the best of one of the termite family, known as the carpenter's friend, from the manner in which it perforates all wooden articles, was shown. The timber from Tobago includes many beautiful woods, conspicuous among which is one, unnamed, deep scarlet in the ground, with a mottling or black irregular spots.

CAPE COLONY.

The great forest of the Cape of Good Hope, or Cape Colony, is the Knysna, situated between Table Bay and Algoa Bay. It is the magnificent remains of the splendid primeval woods which covered the south of Africa. There are about 100 miles along the coast of Knysna under wood, and there are small Crown forests in extent of about 18 square miles.

In consequence of the wasteful destruction of wood which was going on, and which in many places threatened the entire deforesting of the country, the Cape Government recently adopted stringent measures of conservation, which, though very unpopular at present among the blacks, are likely to produce beneficial results. There is now a staff of rangers and guards, who report to Parliament on the state of the forests under their care, through the chief superintendent. The foresters are now required to take out a license, and the forests are being surveyed so that they may be worked in rotation. Premiums are also offered to private persons for the planting of trees; plantations are being formed on the Cape Flats and other waste lands, and Government nurseries have been established which supply trees for the gaps in the forests, and from which young trees are sold at a cheap rate to private planters. How needful such protection had become may be judged from the fact that Norwegian "deals" can be bought at a cheaper rate in Cape Town than the woods of the colony. No wood is of course exported from the colony. The collection of woods exhibited included fifty varieties, chief among which were the stinkwood and the sneezewood, the latter of which, like greenheart, is of great specific gravity, and can resist the attack of marine worms. As showing upon what lines the afforesting of the lands at the Cape are proceeding, it may be mentioned that last year there were in one of the nurseries at Tokai, near Cape Town, over 120,000 young trees, which included 12,500 beefwood (*Casuarina*), 20,000 blue gum (*Eucalyptus globulus*)—a tree introduced with great success into the Cape forests; 10,000 mahogany, 20,000 hakia, 10,000 *Pinus pinaster*, 5,000 sneezewood (*Pteroxylon utile*), and 4,000 ker apple (*Aberia caffra*).

SIERRA LEONE AND GAMBIA.

The timbers shown from these West African settlements were generally of a rough-grained description, and appeared more adapted for the builder than the cabinet-maker. The woodlands are said to be extensive, transport is easy by water, and native labor is cheap, the cost at which some of the serviceable woods of Gambia can be supplied being stated as low as 2*d*. per foot. There seems no reason why, that being so, a great impetus should not be given to the trade of the colony, in timber at all events. The wicker-work sofas and chairs of native workmanship are exceedingly

comfortable looking articles, and show the natives to be possessed of considerable constructive ingenuity, and, from the number of musical instruments shown, they are not devoid of musical taste. Gums and bees'-wax are also products which might be more developed as articles of commerce.

JAPAN.

The Island Empire of the "Rising Sun," which twenty years ago was all but closed to strangers, is to-day one of the most active of the nations. To the exhibition the Government of Japan sent as commissioner Mr. Morimass Takei, chief of the forestry department in Tokio, and with him were two assistant commissioners. The area of the Empire of Japan is about 96,000,000 acres. The forest area—exclusive of the Loo Choo and Bonin Islands—is about 29,000,000 acres. The forests are held in nearly equal proportions by Government and by private owners. Forestry has long been made a study in Japan, and, as is well known, no people are more skilled at grafting and dwarfing trees than the Japanese. The Government forestry department is now an important branch of the state. The head office is in the capital, Tokio, but in each of the forty-four "ken," or states or counties, into which Japan is divided, there is a branch office, from which the respective forests and plantations are managed. During the days of the old rulers each lord had his own forestry laws, all of which were very strict. One of these made it a punishable offense to be found in the forest after nightfall. Since the new regime of twenty years ago the forestry laws have been consolidated and their old feudal strictness somewhat abated. The laws are nevertheless still strict enough to secure the due conservation of the forests. In Tokio there is a Government school of forestry, which was established three years ago, and is now attended by 150 pupils. Some of these are preparing themselves for practical work in the Government forests; others are the sons of land-owners and farmers, acquiring a scientific knowledge of arboriculture in order to qualify themselves for the efficient management of their own lands. The curriculum in the forestry school includes botany, the chemistry of the soil, a little natural philosophy, surveying, and the practical work of planting and rearing trees. Instruction is given to the pupils by Japanese officials, one of whom holds the rank of professor, who have themselves studied forestry in the schools of Germany. Large plantations have been formed under Government auspices, and every year the area of forest land is being added to—cedars, oaks, spruces, and firs being the trees more generally planted. The systematic surveying of the forests is a work that is being pushed forward. Within the past few years an important experiment has been made in the introduction into Japan of the seeds of trees and shrubs from other countries. Tea of course is extensively cultivated, but it was only in 1879 that the first coffee berries were brought from the Sandwich Islands and planted in Japan, and there are great hopes of the successfulness of the experiment from a commercial point of view. The chinchona tree was introduced from India in 1878, but the climate of Japan does not seem to suit it, and in 1880 large importations of the seeds of forest trees were made from America and Europe, and planted in the experimental gardens of the forestry department at Tokio. Some were failures and others took favorably to the country—the list including several firs, oaks, and maples, the birch, the hornbeam, the German larch, the lime, the ash, *Pinus webbiana*, and other trees, which will in time form an important addition to the timber supply of the country. Extending, as the many islands of which the Empire of Japan is made up, over 15 degrees of latitude, and with high central ridges of mountains on the larger islands, the climate differs very much in the north and south, on the plain and in the mountains; so that the vegetation of Japan partakes both of tropical and temperate zone characteristics. On a carefully-prepared chart in the exhibition, by Japanese arboriculturists, the Empire was mapped out into five tree regions or zones. In the first the temperature is high and the forests consist of broad-leaved evergreen trees, of which *Ficus wightiana* is given as a type. Then comes the zone of the oak and the beech and other broad-leaved deciduous trees; next that of the splendid family of cedars, *Thujas* and *Retinosporas* (*arbor-vitæ*), for which the country is remarkable. Higher still is the region of the firs and pines, of which *Abies veitchii* is given as a type—the conifers including many of the stateliest of this most interesting family. Chief among the trees of Japan, however, are *Cryptomeria japonica* and *Retinospora obtusa*, which attain to a height of 120 feet and a girth of 20 feet. To those who have only been accustomed to see small dwarf specimens of the Japanese *arbor vitæs* and conifers used for lawn decoration, nothing is more astonishing than the great slabs of wood which such trees supply in their native country. Of such slabs many specimens are shown, all of splendid quality, and there are also beautiful sections of finely framed camphor wood, lovely maples and bird cherries, junipers and yews—the ornamental woods, indeed, being exceedingly numerous. A very useful hard wood in Japan is keyeki, which has a reddish hue, and there are many varieties of oak, none of which, however, for quality

approach to the English oak. In all, 302 specimens of wood were laid out for exhibition, 271 of which were from the Empire proper, and the rest from Loo Choo and Bonin. There were also four kinds of bamboo indigenous to Japan, by the ingenious people of which they are turned to great account. In a pillared trophy, it should be said, were displayed 96 specimens of Japanese woods, all in repute for their fine quality, pretty color, or curious graining. From one of the trees (*Bronsonetia papyrifera*) the inner bark is taken and manufactured into paper, while from one of the climbing plants the woodmen make their clothing. The wood is steeped in water, then beaten with hammers, and the fibrous mass thus obtained is woven into cloth, which is dyed of a deep-blue color. In the way of timber, the Japanese are able to supply the most of their own wants, and as their houses are largely built of wood the quantity required is very considerable. They export a good deal of timber to China, and import a small quantity from America, that importation being said to be on the decrease. From models and numerous photographs shown, a vivid idea could be formed of Japanese forest scenery and the manner in which the timber cut in the high mountains is transported to the valleys and plains. One of these models represented the timber-shoot, or lade, adown which timber can be sent at the rate of five thousand to six thousand logs per day, and there were also many ingenious contrivances for damming small streams so as to cause artificial "freshets," on the top of which the felled lumber is carried to a lower level. Judging from the specimens shown, the Japanese are clever at cooper-work and basket-making, and of their lacquer-work there were many pretty examples. Among the exhibits of food and fruits were canned bamboo shoots, which are accounted a great delicacy, and there were specimens of eighty different kinds of peaches.

The entomology of Japan was represented by a collection of butterflies, dragon-flies, and beetles, not a few of which were of lovely colors. Included in this collection were specimens of the ordinary silkworm, and five or six other varieties, with their cocoons—the culture and rearing of which is an extensive industry in every province of the Empire. The common silkworm is fed on the leaves of the mulberry tree and produces therefrom the finest quality of silk. The other worms are fed, and thrive well, on the leaves of several of the ever-green oaks indigenous to the country.

One of the models may be more particularly referred to. This was the model of a pond in which timber is preserved, and of which large numbers exist in Japan. They are constructed near the mouth of a river, and into them fresh and sea water is allowed to flow in the proportion of six parts salt to four parts fresh. Should there be a larger proportion of salt water the timber is apt to get blackened; if more fresh, the wood is liable to attack from worms. The ponds are about 5 feet in depth, and by means of canals many of them are often connected together. The timber is piled in the form of a toothed cube, and is kept in the pond from two to five years before being used, the trees most frequently treated in this way being the *Retinosporas* and *Creptomeriæ*, a part of the preserving process being the thorough washing and rearrangement of the wood twice a year. Some of the ponds are made large enough to contain 10,000 pieces of timber.

INDIA.

The extent of country under British administration in India, not including native states, may be put down at 870,000 square miles, of which 246,400 square miles, or 28 per cent., are cultivated, while the rest, 623,600 square miles, is forest, waste, and pasture land. Much of this, of course, is private property, and the total area of forest land at the disposal of the State is not in all the provinces accurately known. There are, however, "reserves" being formed which are to be maintained permanently as forests. At the present time the total area of reserve forests is 29,371 square miles. These are termed first-class reserves. Of second-class reserves in the central provinces there are 16,842 square miles. Legally they are reserved forests like those of the fi[rst] class; no customary rights can accrue in them, and no land can be alienated with[out] the sanction of Government. But they are not so strictly protected, as the fi[rst]-class reserves and their boundaries are not so clearly defined. Eventually a portion of these second-class reserves will be given off for cultivation and the remainder added to the first-class reserves. In all the provinces large additions to the reserved area are steadily made. It is less than forty years ago that the Indian department of forestry—now an important branch of the Indian civil service—was organized by the East India Company. Up to 1850 little, if anything, had been done to check the wasteful clearing of the magnificent primeval forests of India—a destruction which, if continued, would have reduced many districts into arid wastes such as the uplands of Afghanistan have become through the deforesting of that once fertile country. It is most interesting to learn, as illustrating the ameliorative influence of tree-planting on the climate of a country, that the resu[lt] of planting operations along the frontier towards Afghanistan and Beloochistan is already beginning to be felt in a gradually increasing annual rainfall in the Southern Punjab, Southern Afghanistan, Northern Beloochistan, and Northern Scinde.

"What a triumph," says the Scotsman, "it would be for science were the Central Asian problem to be solved, not by the sword, but by the planting of trees, whose beneficent influence should change the fierce predatory hillsmen into quiet agriculturists, and cause the desert again to rejoice and blossom as the rose." The forestry department of India has been a great commercial success. Before 1848 the forest revenue was very trifling. In 1881-'82, the income of the department was over £874,000; the expenditure, £557,000; leaving a net revenue derived from the systematic management of the woods of £317,000. The surveying of the Indian forests is now being steadily accomplshed. As showing the rate at which it is proceeding it may be mentioned that last year (1883) 361 square miles were plane-tabled, on a scale of 4 inches to the mile, and 85 square miles triangulated. The result of these labors was seen on the walls of the Indian court of the exhibition in a series of splendid maps, which, as the forests in the different provinces come into full working order, will be indispensable in connection with their efficient management. In Great Britain there are only 40 species of indigenous trees, while in India they number over 2,000. An important tree in the Northern Indian forests is the deodar (*Cedrus deodara*), which, under favorable conditions, attains a height of over 200 feet, and is famed for the durability of its timber. In the climate of India many woods are apt to decay and to be destroyed by insects a few years after having been cut. Deodar is one of the few durable woods in India, and beams of it have been known to last several hundreds of years. There are also extensive forests of sal (*Shorea robusta*), and sissoo (*Dalbergia sissoo*), the timbers of which are also very durable. Sissoo, which takes on a fine polish, is largely used in furniture-making and carriage-building. *Acacia catechu*, from which the catechu of commerce is obtained, is also a wide-spread forest tree. This valuable tanning material (catechu) is extracted by simmering chips of the heartwood in water and boiling down the red fluid into a hard, shining black mass. *Ficus elastica* is another important tree. In 1881-'82 the export of India rubber amounted to 10,680 cwt., valued at £108,843; and in Assam, especially, large plantations of this valuable tree are being formed. But of all the Indian forest trees the well-known teak is perhaps the most important. The home of this tree is the moist regions of tropical India, and in the Transgangetic peninsula, in Burmah and in Siam. Indian teak is more prized than any other timber, as it is not only exceedingly durable, but it works well, takes a fine polish, and does not split or warp. Some magnificent logs of teak from Burmah were shown, and its adaptability for furniture-making and art-carving purposes were abundantly illustrated—some of the native carved work in teak being of a most artistic and delicate nature. Its price is very high at present, from £15 to £16 the load of 50 cubic feet in London. During the last three years the mean annual yield of the Government forests in British Burmah was 24,000 tons of teak, and the imports into Rangoon and Moulmein from beyond the frontier was 145,000. But as the forests beyond the frontier are worked without any regard to the future, it is impossible that they can continue to yield in same quantities as hitherto. On the other hand, the yield of the Government forests may be expected to increase—the aim being to plant and protect teak so that the Government forests will by and by yield as much as is imported into Rangoon and Moulmein from beyond the frontier. In the working of the Indian forests the principles followed are the same as those upon which the state forests of France and Prussia are worked, the chief aim being steadily to improve the condition and never to cut more than the annual production, by natural or artificial means, will justify. "Forest management," says Dr. Brandis, late inspector-general of Indian forests, "which aims at these objects, requires the following measures as essential conditions of success: First, effective protection; second, a good system to secure the regeneration of forests, either naturally by self-sown seedlings or coppice-shoots, or artificially by planting, sowing, and other cultural operations; third, good lines of communication to facilitate protection, the working of the forest, and the export of produce; and, fourth, well-considered and methodically-arranged plans of working." One great point gained by this management is, that over large areas it has been possible to put a stop to annual forest fires; and the eradication of forest creepers, which stunted the growth of the trees, has also been successfully attempted. Of the staff of officers employed for forest administration in India, there are fifteen conservators, or chief forest officers, of the forest circles into which the peninsula is divided. Each forest circle is again divided into a number of divisions, each under the charge of a superior officer styled a deputy or assistant conservator, and these divisions are subdivided into ranges varying from 20,000 acres to 30 square miles in size. Ranges, again, are further subdivided into beats, and are under the charge of forest guards. The Indian forest service is thus divided into these main branches: The controlling or administrative staff (conservators, deputy and assistant conservators), in charge of forest circles and divisions; the executive staff (forest rangers) in charge of ranges, and the protective staff (forest guards) in charge of beats. Only the controlling or administrative staff is recruited from Great Britian. The officers of the executive and protective staff are all natives of India. Appointments to the controlling staff are made in the usual

manner in which civil servants of the Crown are appointed. As there is no forestry school in Great Britain, candidates have to attend the schools of France or Germany. For the qualification of native forest rangers a forest school has been established in Northern India, to which four forest divisions, situated in the plains and in the hills of the Himalayas, have been attached. The arrangement is that eight months in the year are devoted to practical work in the school forests, while the remaining four months, during the slack season in summer, are devoted to theoretical instruction in mathematics, the natural sciences, and forestry. Surveying is taught in the school and in the fields. All these students are taught in English, as they come from many different provinces. Recently a lower class has been established for those who only aspire to the certificate of forester—a class intermediate between forest rangers and forest guards. To them, instruction is given in Hindustani. The display of timber and forest products from India constituted one of the features of the exhibition. From Calcutta was sent what was known as the "Index collection," which comprises 800 specimens of the different chief woods of India. The collection is a museum collection, each specimen being marked with its scientific name and alphabetically arranged. Its geographical location is also indicated. Many of these woods, such as the well-known ebony, the blackwood, and sandalwood, are worked up into furniture and cabinets of a beautiful kind. The richness of India to produce such articles of commerce as gums, oil seeds, perfumery, medicinal barks, and dye-stuffs was also illustrated. In the specimens shown, great commercial possibilities are suggested. From the Andaman and Nicobar Islands some splendid specimens of wood were shown. One slab of the tree *Calophyllium inophyllium*, known to the natives as "Poon," was unsurpassed by anything in the exhibition. It was of great size, and in color was like light polished mahogany. There were also splendid logs of "Padowk" (*Pterocarpus indicus*) whose coloring varies to a remarkable extent in different trees, ranging from that of cedar to dark mahogany, and frequently being found of a deep scarlet. An evergreen tree indigenous to those islands, which is used for fancy cabinet work, is the marble wood (*Diospyros kurzii*), the texture of which is alternately streaked gray and black. It may be mentioned before leaving India that attempts have been made to introduce into the Peninsula trees from other countries. Of the trees of Northern Europe and America none have been raised on a large scale, as the climate is so different in India. The mahogany tree was brought from the West Indies about ninety years ago, and there are a number of large trees in gardens near Calcutta which produce timber equal to that of the American tree. Great exertions, says Dr. Brandis, have been made to grow this tree on a large scale in forests, but the success has, with few exceptions, been indifferent. In Pegu, however, the mahogany is likely to succeed as a forest tree. The Rain tree (*Pithecolobium saman*) of tropical America, which is a rapid grower, has succeeded wonderfully well in most of the moister districts of tropical India; and several tropical American trees which yield caoutchou rubber, notably *Manihot glaziorii*, have been tried with success. The Paper tree of Japan, which is grown in a coppice in the same way as observed in England, is cultivated in Assam and Burmah, and promises to be an important production; and another foreign tree which has succeeded splendidly in India is the Blue gum of Australia (*Eucalyptus globulus*). The blue gum was first introduced into India in 1843, and there are trees at Ootacamund thirty years old 110 feet high and 13 feet in girth. The mean annual production of wood in the blue-gum plantations—as ascertained by actual survey—has been at the rate of 10 tons, or 500 cubic feet, of solid wood per acre, which is more than five times the quantity produced by high timber forests in Europe.

CEYLON.

A very interesting collection of the products of Ceylon was sent to the exhibition through the enterprise of one of its planters, Mr. I. Alexander, of Udapusalawa. A very interesting part of the collection was that relating to the harvesting of the chinchona bark, and its preparation for market. Last year as much as 7,000,000 pounds of the bark were exported from the island—this industry being one of great importance in it. Formerly the trees were regularly "shaved" with small planes for their bark, but this method of "harvesting" has been mostly given up. The chinchona is now "coppiced," and a rotation in dealing with them observed. One of the species, *succirubra*, is a fast grower, attaining, in the low country, to a height of 50 feet in twenty years. The products of the cocoa-nut and Palmyra palm are also of great importance in Ceylon. The island of Ceylon has long been famed for its coffee. For some years past, however, the cultivation of the coffee-plant has greatly decreased, a blight in the shape of a fungus which stripped the plants of their leaves, having done great damage in many districts. Not a few of the planters have tried tea as a substitute for coffee, and with great success. The fauna of the island was represented by a small collection of stuffed birds, conspicuous among which are the snake eagle, the painted snipe, the jungle crow, and the jungle cock; and there was shown a small but nicely got up collection of butterflies and beetles with their larvæ—most of which

are very destructive to trees. One species is very injurious to the chinchona tree. It is the custom of the coolies to turn out and gather the chinchona caterpillars in baskets, and in that way their depredations are lessened.

Hard by the Indian court might be seen a very practical collection from Iohore, in the Malayan Peninsula, the Maharajah of which is a very enterprising and intelligent ruler. From this place there were 350 specimens of timber trees and samples of valuable camphor, gums, and gutta-percha—the last-mentioned article having first found its way into the market from Iohore. The Maharajah owns extensive saw-mills, of which photographs were shown, and there was also on exhibition a complete set of Malayan tools and implements, which show that, with slender means at his disposal, the Malay can cut down the largest trees and build his houses and boats.

Singapore and Siam were also represented, the Government of Siam having an exhibit including 500 specimens of different trees, most valuable of which are the teak, sandal, ebony, and rosewood. The Mauritius court was chiefly noteworthy for its large and varied collection of fibers, numbering over two hundred, and ranging in quality from the finest silk thread to coarse matting. All are derived from indigenous trees, shrubs, or plants.

The Australian colonies and New Zealand may be said to have been unrepresented. From South Australia the conservator of forests of Adelaide sends some forest reports, from which it appears that the provincial legislature has passed several acts to prevent the willful destruction of the indigenous forests of the colony. New South Wales sent sections of the *Eucalyptus globulus*—a tree which seems destined to effect a revolution in the climate of several countries cursed with malaria. In India, as already stated, hundreds of thousands of blue gum have been planted, and it has been planted with the most beneficial results, in Cyprus, Italy, Spain, and Algiers.

CYPRUS.

This island is a standing example of the melancholy effects of deforesting. Once regarded as one of the richest and most fruitful islands of the Mediterranean, when it fell under the power of the Turk it was stripped of its woods with the most baleful effects. The rainfall diminished, water-courses dried up, swamps formed on the sea-shore, and the island was visited by deadly malaria. On falling into the hands of Great Britain, one of the first duties of the British governor was to see to the preservation of the few remaining patches of forest and to plant hundreds of thousands of blue gum trees on the low swampy grounds of the coast, with the view of neutralizing the malarial exhalations from the soil. These plantations are only five years old, but they are said to be exercising already a very beneficial result. Mr. E. Dodds, the principal forestry officer under the British Government, sent a small collection of the woods of the island, which, however, are only of antiquarian interest. They simply speak of what once existed in the island. *Pinus halepensis*, the Aleppo pine, is the most common of the old trees. The shittim wood of Scripture (*Cupressus fastigiata*) was also formerly abundant, and there are still some patches of the cedars of Lebanon. The island possesses an oak peculiar to itself, *Quercus alnifolia*.

EUROPEAN GOVERNMENTS.

It has been a matter of regret that some countries, particularly France and Germany (and also the United States), which yield a large amount of timber and forest produce, did not respond to the circular invitation of the executive committee to be present at the exhibition. Where direct participation, in so far as exhibits are concerned, was impossible, official maps and publications bearing on the forest service have in most cases been sent. Of the continental Governments, Denmark and Norway and Sweden were the chief exhibitors. Denmark has suffered from deforesting, but the Government is now alive to the importance of forestry. About 500,000 acres of the country are under forest. The old forests of beech and oak have been allowed to become well-nigh exhausted, but the remains of them are very fine. Considerable areas have of late been added to the forests, the number of acres during the past quarter of a century being 63,600. The Crown forests are now systematically managed by a large staff of foresters, and a society also exists for the planting of moors and waste lands with trees. In the first instance such ground is covered with spruce and fir, but the idea is that after these trees have come to maturity their place should be taken by hard-wood trees. Of its native woods 81 per cent. of the quantity cut is used in the country annually for firewood, and there is imported about one million sterling worth annually, £138,000 of which is re-exported in a manufactured state. Of these manufactured articles, such as barrels and a variety of cooper-work, there was a large exhibit in the hope that a market may be found for them in Britain. Denmark sent an admirable series of forestry maps, which included a chart showing the mean heights of various forest trees from twenty up to one hundred and twenty years of age, and the cubic contents of timber per acre at the same stages of growth. This

diagram shows that in Germany the height of beech and spruce is greater than in Denmark, but that the average diameter of the same species of trees in Denmark exceeds that of the trees in Germany. There were also shown models of heavy plows for use on the waste lands before they are planted with trees, and a large harrow or grubber which is worked in the Danish forests for breaking up ground under old trees so as to give seed self-sown a better chance of germinating and springing into life.

SWEDEN AND NORWAY.

A very practical exhibit was sent. Hitherto the chief exportation of timber from the Scandinavian peninsula to Great Britain has been in the shape of "deals." Planed barrels of large size, plain moldings, herring barrels, and such like articles were shown with the view of stimulating a demand for them in Scotland. Sweden and Norway have long been known as one of the chief homes of the great pine and fir family. To the United Kingdom alone timber to the value of £3,300,000 is exported from Sweden, and from Norway, £1,600,000; and large quantities are also sent to other countries. In the matter of forest conservancy, neither in Norway nor Sweden has much been done, and the woods have suffered in consequence. In Sweden a better feeling on the subject is general, and Government and private enterprise are working together to repair the damage to the splendid pine forests which has been caused by wasteful methods of forestry. In Norway, forest regulations are resented as an interference with popular rights, but here, also, common sense is prevailing over unreasoning prejudice.

WOOD-PULP PAPER-MAKING.

From Germany, Norway and Sweden, France, and Denmark (private firms) came interesting illustrations of a comparatively new but rapidly increasing industry—that of making paper from wood. Ten years ago Germany went practically, and on a considerable scale, into this business—stimulated by the great demand there was for cheap paper, especially for newspapers, and it spread into Norway and Sweden and Denmark. In Germany there are said to be 60 wood-pulp mills in daily operation. In Norway there are mills with 12,000 indicated horse-power, and in Sweden mills with about 3,000 horse-power. The wood chiefly used in the process is pine wood, that about 20 years of age being considered most suitable, as the fibers are not too brittle. Aspen (*Populus tremulus*) is also used. There are three methods of reducing the wood to pulp. In two the initial processes are the same. Cut transversely by machinery into small pieces, after having been barked—or it would be more correct to say thin slices—the wood is boiled in water under high pressure. In one process, known as the "soda process," it is afterwards treated likewise under great heat, with caustic soda, which leaves it a pure cellulose mass. This mass is subsequently washed and passed through an ordinary "breaker," then over a machine with an endless sieve or felt, from which it issues as a roll, or what is known in commerce as wood-pulp. In the other process, known as the "acid process," the wood is treated with sulphuric acid instead of caustic soda. In color, the "wood-pulp" is light gray, and when dry it is of great tenacity. By the soda process, 2 to 2¼ tons of wood are required for one ton of pulp, which is quoted in London or Leith at £17 the ton. Considerable controversy exists as to the merits of the two processes, but the respective pulps sell at about the same price, and, except by very experienced paper-makers, could not be distinguished. The other process is known as the "mechanical process," the wood being simply ground—practically in water—into minute fibers and partially dried in the usual manner. A very excellent model of a wood-grinding mill was shown by Mr. Carl Christensen, one of the Norwegian exhibitors. All the wood-pulp mills in Norway are driven by water, which greatly cheapens the cost of production. In this model the logs are brought in a "lade" up to the saws and cut into pieces varying from a foot to two feet in length. These pieces are in turn barked and split by machinery, and passed on to have the knots bored out and the pith removed. Upright grinding-stones are kept revolving in water or, at all events, are kept drenched with water, and against these stones the wood is held by a hydraulic piston, which can be adjusted so as to produce long or short fiber. Open pipes carry the water with the fiber in suspension—the mass resembling a cloudy stream—onto the knotters or sieves, which check the passage of unground chips, while the strained material is carried onto an ordinary paper-making machine with an endless web or fine sieve, whence it issues in the shape of large sheets. These, under hydraulic pressure, have 50 per cent. of the water squeezed out of them, and the pulp thus manufactured is ready for sale, the price per wet ton in London being £3 10*s*. Mechanical pulp is very brittle, and requires the admixture of more cellulose material before it can be worked up into paper. Wood-pulp now forms a large part of the raw material of the British paper-maker, who uses it especially in the manufacture of cheap paper for newspapers. It was only under the severe pressure of foreign competition that

British paper-makers were ultimately driven to its use. The display of wood-pulps being new to a large portion of the public, formed a very interesting feature in the exhibition.

NEW BRUNSWICK.

The only Canadian province represented at the exhibition was New Brunswick. Of the indigenous woods of the colony there were 40 different specimens shown. They were mostly of a light color, the samples of ash, bird's-eye maple, and birch being particularly fine both as to color and texture. The hemlock tree (*Abies Canadensis*), the bark of which is largely used in the United States as a substitute for oak bark in tanning, was also shown. The exhibit was the joint property of the government and the New Brunswick Land and Timber Company, who seek for settlers on about one million of acres on the St. John and its tributaries, where the land, resting on the Upper Silurian formation, is said to be exceedingly fertile. This land is at present covered with hard-wood trees, and on these forests little impression has yet been made by the lumberers' axes. There is as yet no supervision of the forests worthy of the name, and no instruction in forestry is given in any Government institution.

MANITOBA.

The Canadian Pacific Railway Company had an exhibit on the open ground, which attracted a great deal of notice. This was a model Manitoba farm, consisting of a two-roomed house, log stable, and the implements and wagons used by the settlers. Different articles of useful furniture, suitable for such a dwelling, were also shown.

THE REDWOOD TREES OF CALIFORNIA.

Of the redwood trees of California and the uses to which they may be put there was an excellent illustration. A section of a giant *Sequoia* 13 feet in diameter was shown, and there were also some splendid slabs of wood of great size and beautiful quality. By a local firm of cabinet-makers there was exhibited an ornamental trophy showing the adaptability of the wood for furniture purposes and interior decoration. For both purposes the wood appears exceedingly suitable.

LARCH DISEASE.

(*Larix Europea.*)

The larch, which was first introduced into Scotland about 150 years ago by the Duke of Athole of that day—the "planting Duke," as he was called—and was found a most profitable, fast-growing tree, has for a considerable number of years shown signs of deterioration. Larch plantations have been ravaged by disease in every part of the country, and in accounting for it practical foresters are by no means agreed. The tree seems to be more or less infested with insects and ulcerated wounds, through which the sap bleeds, to the serious injury, if not destruction, of the tree. Bad seed, undue forcing in the nursery, deterioration of the climate, exhaustion of the soil, spring frosts, and careless management have all been blamed for the disease. Many specimens of larch wood, both in a sound and unsound state, were exhibited. One young tree in a tub, sent from the Athole plantations, was covered with a pest of the larch plantations—a minute aphis apparently closely allied to the cochineal insect. The tree looked as if it had been dusted over with white flour, which conceals innumerable microscopical insects, under whose attack the young larches receive a severe check or succumb altogether. Plenty of air and room for the tree to grow in are the best means of routing this enemy—close, unthinned, and badly tended plantations being more liable to be attacked with it than others kept more open. Dry-rot also attacks the larch. What is known as "blister" in the larch is the most common form the disease takes, the ulceration being the means as already hinted of bleeding the tree by degrees to death. The disease is a cause of great anxiety to planters, many of whom have immense tracts of mountain land, in the Highlands, under larch.

MISCELLANEOUS.

There were not a great many exhibits of a practical nature worthy of detailed notice.

Practical foresters have had their attention directed to a system of pruning exhibited by the Count des Cars, Paris, whose idea is to keep the tree, by pruning, in "perfect equilibrium," which, it is averred, helps the enlargement of the trunk. There were many exhibits of foresters' tools, and an opportunity has been afforded of comparing those in use in different countries. Several tree-transplanters were shown.

One by Mr. James Whitton, gardener, Coltness, Wishaw, seemed the best. It is a two-wheeler, on the "Ianker" principle, and is capable of removing trees 30 feet high and weighing 2 tons, one of its advantages being the ease with which its lever-power can be applied in lifting the tree from the earth. Several simple and efficient plans for transplanting shrubs so as to preserve the "ball" intact were shown by the same exhibitor.

Messrs. Benjamin Reed & Co. showed a "simplex pump"—for draining ditches or for use in connection with liquid manure—the valve action of which is so simple that it cannot be choked or thrown out of gear; also a powerful root-extractor, which gives a sufficient leverage to enable one man, it is said, to lift 5 tons; and they have an ingenious iron tar-barrow, with brazier and pot, for use by foresters when tarring fences.

Mr. N. Ahlbottn, Leith, showed a patent composition for the protection of young trees from game, which has been attested to be of great utility by many eminent foresters. The composition is tar-like in color and consistency, non-porous in its nature, does no damage to the tree to which it is applied, and is regarded with great aversion by hares and rabbits.

William Wells, Leith, exhibited an approved composition for the filling up of cavities in trees so as to prevent the lodgment of water and subsequent decay; and alongside of it was a patent varnish made of marine glue and fusel oil—one of the waste products of the distillery—which can be used as a substitute for creosote in preserving fencing, sleepers, and such like exposed timbers. Applied to stout paper it acts as a water-proofing agent, and strips of this prepared paper wrapped round a tree are found to preserve it from the attacks of ground game.

A. Gardener & Son, Glasgow, exhibited timbers prepared and preserved by a patent process for which it is claimed that it not only seasons timber in about one-twelfth the time, but greatly increases its strength.

Mr. James Dairsie Morrison, of Swanston, near Edinburgh, a gentleman who has made ventilation subjects a "hobby," showed an ingeniously constructed model of a forester's hut, which aims at providing within the space which can be afforded in such dwellings the most perfect conditions of healthy life. The principle embodied is that of maintaining in an apartment, without creating an objectionable draft, a continuous current of pure air. This fresh air is made to enter at one end of the room so treated and to leave it at the other in a sort of drain under the flooring, this drain being carried into the flame chamber of a newly-invented oil lamp used for heating the room, where all impurities are burned. The same exhibitor also shows a drying shed in which there is sought to be obtained the drying of wood at a low temperature, and at the same time the poisoning of all the conditions of low plant and animal life. The low amount of heat applied is made to evaporate from the cells of the wood every trace of water, and at the same time to act as the carrier of gaseous poison, such as carbonic acid in different shapes, which, though harmless to the woody fiber, kills all low forms of plant or animal life.

There were several inventions for making wood non-combustible; the cheapest and best was said to be Wilkins's fire-proof paint, shown by Craig & Rose, Leith.

The marquetry work exhibited by D. Mongenot, Paris, attracted much attention. It is a branch of furniture and decorative art not much practiced in Scotland, but which is taught to a considerable extent in the technical schools of France. Working with veneers cut to thinness ranging from 20 to 110 to the inch, the artist frets out his design and then fills up the pattern with small pieces of differently colored natural woods, the effect being heightened by the introduction of woods previously stained in the block. A table-top and several ornamental panels shown were very pretty, the shading especially being most delicately managed. There was also shown a log of maple 15 inches in diameter cut into a paper-like roll of veneer 340 feet in length.

Of parquetry work, which is a species of wood-inlaying applied to produce ornamental flooring, there were several very fine samples, notably by Arrowsmith & Co., London.

The Jocul cabinet and furniture makers had an annex all to themselves, and their work, in sideboards and suites of furniture, was in the highest style of art and workmanship.

The rubber manufacturers were also well represented, and the adaptability of rubber as a water-proofing material and for use in machinery was abundantly illustrated. In motion, was shown on the outside grounds, the most approved wood-cutting and preparing machinery. This, to many, was an interesting part of the exhibition.

The outside grounds referred to were for the most part allotted to nurserymen, who had laid them tastefully out, and showed in them the newest ornamental conifers and other trees. A remarkable fact about the display, which was of a most interesting nature, was the large number of such trees which came from Japan.

In what was styled the loan collection, there were 150 exhibitors—the exhibits

comprising the most miscellaneous collection of articles, curious and otherwise—more or less associated with forestry and forest produce.

Dr. Brandis, late inspector-general of forests, India, sent a steel diameter gauge, made by Theophil Beck, Kehl, near Strasburg. This instrument is used in the forests of the Prince of Furstenberg, and is certified by Dr. Brandis to be the best diameter gauge for foresters.

A new instrument for expeditiously measuring heights and distances in a simple and accurate manner was shown by D. F. Mackenzie, factor, Morton Neall, inventor and patentee. It is styled a "dendrometer," and it has received the silver medal of the Scottish Arboricultural Society. Not only does Mr. Mackenzie's dendrometer measure the height of a tree or other object in the same manner as other dendrometers when a horizontal base line can be measured, but it also measures with ease and accuracy the height of any object which can be seen from any standpoint, whether upon an ascending or descending base line. The dendrometer being placed in position and the base distance measured, the instrument is adjusted in an instant, and the height of the object is immediately ascertained by reading off the figures on the perpendicular limb of the instrument. It can also be used with the same facility in finding the distance to any object, which is a novel feature in any instrument of the kind, and likely to make it extremely useful for a variety of purposes besides those of the forester.

ZOOLOGY.

Of the animals frequenting woods and forests and the insects which are destructive to timber, a considerable display was made. Captain Wardlaw Ramsay exhibited a very fine collection of woodpeckers, numbering nearly 300, from the splendid collection of birds, comprising over 50,000 specimens, which were left to him by the late Marquis of Tweeddale. America, of course, supplies the larger number of the species. Some of them shown are very rare. In the Indian collection were two fine specimens of the great horn-bill—a bird which makes its nest in the hollow trees. It is the habit of this small bird to make his partner a prisoner during the entire period of incubation, and this he does by plastering up the entrance to the nest, leaving only a narrow slit through which he feeds his imprisoned mate. British Guiana birds and insects have already been noticed. Trophies of the chase were lent by the Prince of Wales, the Duke of Edinburgh, and other noblemen and gentlemen, and included the heads of all sorts of game, from the elephant and tiger to the stag shot in the Balmoral forests. Of the insects which do damage to trees, the most complete collection was that sent by the reporter. A few cases of British insects were exhibited, but for the most part the insects were not named nor the species of tree of which they are the pest distinguished. In the Indian department the ravages of the carpenter bee and the white ant were exemplified, and there were also sections of wood showing the mischief done to timber by marine worms.

ADDENDUM TO NOTES ON THE INDIAN COLLECTION.

Since writing the notes I have learned that the authorities of the India office have decided, after much consideration, to *discontinue* the system of training young men for the Indian forestry service on the continent. Henceforth the resources within this country (Great Britain) will be utilized for the education of forest candidates. The Royal Engineering College, Cooper's Hill, Staines, is the place selected in the first instance. There a thoroughly good teaching staff already exists, and the proximity of the college to the royal gardens at Kew will be of advantage to the students. One thing is needed—a tract of forest secured for systematic management and professional instruction.

NEW ORLEANS CENTENNIAL EXPOSITION.

At the approaching World's Industrial and Cotton Centennial Exposition at New Orleans the appropriation made at the late session of Congress will enable the Department to make an exhibition illustrative of forestry, which, though far from being complete, it is believed will form an interesting feature of the Exposition, and show to the multitudes who are likely to visit it the practical value and importance of the work which the Department is engaged in through its Forestry Bureau.

Personal visitation of many of the wood-working factories of the country by the chief of the Bureau and some of its agents, and an extensive correspondence on the subject, have resulted in securing a large

collection of useful, convenient, and ornamental articles, for the supply of which we are indebted to our forests. These have been sent to New Orleans, and it is proposed, when the Exposition there is closed, to bring the collection back to Washington and place it on permanent exhibition in the Annex of the Department as a practical illustration of the value of our forests and the importance of the work of forestry.

Several charts or graphic maps have also been constructed by the Bureau for the New Orleans Exposition, for the purpose of showing at a glance the relative amount of forests in the several States and the diminished area of forests from one decade to another.

FORESTRY EXPERIMENT STATIONS.

In concluding the report of the work of the year I renew the expression of opinion that the establishment of Forestry Experiment Stations by the Government, alone or in connection with the several States through their agricultural colleges, is very desirable and ought not longer to be delayed. Such stations are greatly needed. They are needed, among other things, for the purpose of testing the best methods of planting and cultivating trees, to ascertain the adaptation of trees to different soils and exposures, to decide some questions in regard to the influence of trees upon the atmosphere in their vicinity, to investigate the history and habits of insects which are injurious to trees and the means of checking their ravages. There are a great many questions in regard to the growth and management of trees, arising from time to time, which for their satisfactory investigation require some such agency as an Experiment Station, where scientific and patient observation can be secured under the most advantageous circumstances and without disturbance or interruption. Such experiment stations might well be established in each of our States. In every point of view they would be advantageous. It might be desirable, perhaps, for the General Government to co-operate with the States by making appropriations which would in part meet the expenses of such stations, and having in return a voice in their management. But it would seem that there should be one, if not more, of such stations, which should be under the control of the General Government alone, which should be managed in a broad and comprehensive way and be restricted in its investigations by no local situation or considerations.

SCHOOLS OF FORESTRY.

In my report of last year I gave such consideration to the subject of Schools of Forestry and treated of them at such length that there seems to be no occasion now to do more than express the opinion that the time has come when we should lay the foundation of at least one such school of instruction in forestry.

Respectfully submitted.

N. H. EGLESTON,
Chief of Bureau of Forestry.

Hon. GEORGE B. LORING,
Commissioner of Agriculture.

REPORT OF THE CHIEF OF THE BUREAU OF ANIMAL INDUSTRY.

SIR: I have the honor to herewith transmit my annual report for the current year, embracing the results of the more important experiments and investigations of the Veterinary Division previous to the passage of the act creating this Bureau, and a part of the work accomplished since its organization. For a detailed statement of the work of the Bureau, embracing the results of experiments in the laboratory and experimental stations, and many important investigations made by its experts and agents, I have to refer you to the First Annual Report of the Bureau of Animal Industry.

Respectfully submitted.

D. E. SALMON, D. V. M.,
Chief of Bureau of Animal Industry.

Hon. GEORGE B. LORING,
Commissioner of Agriculture.

INVESTIGATIONS OF PLEURO-PNEUMONIA.

DISTRICT OF COLUMBIA.

No systematic inspection of cattle has yet been made in the District of Columbia, but we have secured a number of sick cows which have been slaughtered and examined in order to determine the nature of the disease from which they were suffering. Other cases have been brought to our attention by Dr. Townshend, the able health officer of the District, in regard to which we have made all the investigations that were possible. During the year we have in this way found the disease in ten stables in which more than one cow was kept, and in three others in which the diseased animal was the only one owned. In one stable two have died; in a second, one had died and two were sick; in a third five had died and six were more or less affected; in a fourth, two had been lost; in a fifth, six had been lost; in a sixth, five had died; in a seventh, three had died; and in the remaining three stables the loss, so far as we are aware, has been one animal each.

The total number of animals referred to above is twenty-seven which have died, and eight which were sick at inspection. In these cases the symptoms and *post-mortem* appearances of the animals examined were those of contagious pleuro-pneumonia, and the history, when it could be obtained, also pointed in this direction. The following instance is an illustration of this:

A cow belonging to Mrs. Flanigan, of Benning's road, was discovered sick, May 22, 1883. The symptoms were a severe, dry cough, emacia-

tion, arched back, extended head, and turning out of the elbows. Percussion and auscultation showed that there was dullness and loss of respiratory murmur over the right lung.

This animal was preserved until August 27, and then slaughtered. The anterior portion of the right lung was found to contain a large encysted mass of hepatized lung tissue, fully 5 inches in diameter, which was beginning to disintegrate and break down into pus. The left lung was affected with chronic bronchitis, and many of the bronchi were filled with a thick, white, tenacious pus.

The disease was brought to this stable in the latter part of December, 1882, by a cow dealer who lives near the navy-yard. She presented symptoms of disease in about two weeks after purchase and lingered for six weeks with symptoms of acute lung disease. Three weeks after the death of this first cow a second became sick, with similar symptoms, and died after four weeks' illness.

Two others were successively affected in a similar manner and died; and, finally, the fifth came down with the disease about the 1st of May, 1883.

On May 29, 1883, we received at the Veterinary Experiment Station a cow from the stable of Catharine Bresnahan, of Lincoln avenue. This animal was somewhat tympanitic and stood with arched back, elbows turned out, and extended head. With each expiration there was a loud moan. Examination over the lungs revealed dullness, tenderness, and loss of respiration on the right side.

This animal died during the night of June 3, and was examined the following day. The right lung was found to be firmly attached to the ribs and diaphragm over nearly the whole surface of contact. This lung was almost completely hepatized; the posterior part was gangrenous; the median portion showed old hepatization, in which there was little difference in color between the lobular and the interlobular tissue, while the anterior portion was freshly hepatized and presented the distinctly marbled appearance seen in acute pleuro-pneumonia, and thought by some to be characteristic of that disease. The condition of this lung showed beyond question that the inflammation was a progressive one, and, beginning in the posterior portion of the organ, had successively invaded the median and anterior portions.

The existence of inflammation of different ages, showing the progressive character of the disease, is now regarded by the leading authorities of Europe as the most satisfactory means of distinguishing between contagious pleuro-pneumonia and the sporadic inflammations of the respiratory organs. The pleural cavity contained about a quart of effusion, and the mucous membrane of the bronchial tubes was of a deep red color.

This animal presented, consequently, all the symptoms and *post-mortem* appearances described as peculiar to pleuro-pneumonia. The only history that could be obtained was that a number of cows had previously been affected in this stable with similar symptoms.

September 18, 1883, I examined a cow on Nineteenth street, which had rapid and difficult breathing, with extended head and elbows turned out as in cases of pleuro-pneumonia. There was dullness over the lower half of both lungs, with resonance above, but no respiratory murmur could be detected over the left side from the shoulder backward. This animal died on the morning of September 21, and on examination the left lung was found solidly attached to the ribs and diaphragm. There was an abundant effusion of liquid into the pleural cavity; the pericardium was greatly distended and attached to the costal pleura. On section

the lung was found free from hepatization, but the pericardium was greatly thickened and transformed into a fibrous cyst inclosing the heart. The surface of the heart showed that this organ had been intensely inflamed; it was roughened and covered with granulations, mostly gray in color, but over parts of the surface mottled with deep red. The heart tissue, to a depth of half an inch from the surface, had undergone fibrous degeneration, was colorless, and resisted the knife. A painting was made of this organ and is reproduced in this report as Plate IV*; it shows very plainly the thickened pericardium, the mottled appearance of the surface of the heart, which organ was cut across to reveal the depth of the fibrous degeneration.

There may be a question as to the exact nature of this disease—whether it was induced by the virus of lung plague or whether by other causes. No diseased animals had been introduced on the place, but there had been opportunity of exposure to animals running at large. The absence of hepatization is not conclusive evidence that it was not lung plague. This disease quite often confines itself to the serous membranes without appreciably affecting the lung tissue, and pericarditis and epicarditis are manifestations which have been described as occurring in the infected stables of Europe. I am inclined to think, therefore, that this affection was the result of exposure to the lung-plague virus.

January 12, 1884, three cows were slaughtered at the Veterinary Experiment Station in presence of Hon. James Wilson, of Iowa, member of the House Committee on Agriculture, and of delegates from the Chicago convention of stockmen and of distinguished veterinarians, in order to demonstrate the character of the disease from which the cattle in this vicinity were suffering. The first one was a young cow that I found January 1, 1884, at the stable of the owner near Washington. At that time her breathing was rapid and labored, a distinct grunt or moan being emitted at each expiration. On percussion over the region occupied by the lungs the right side was found perfectly dull and without resonance, while the left side was resonant over the upper half, but very dull below. Auscultation showed complete loss of respiratory murmur over the whole of the right and over the lower part of the left side. There was no cough.

This cow had been purchased about a month previously, from a dealer who had brought her from the Shenandoah Valley, in Virginia, and had kept her for a number of days (the exact time not known) at his stable in Washington. She was noticed to isolate herself from the remainder of the herd while at pasture, and to be disinclined to move, almost as soon as she was placed with the herd. She commenced moaning at each expiration more than two weeks before I saw her, and was then separated from the other animals. January 2 she was removed to the Experiment Station, her temperature at that time being about 103° F.

This cow died during the night of January 11, and was examined about 11 o'clock the following day. On opening the thorax about 2 gallons of amber-colored liquid escaped. The right lung was solidly attached to the costal pleura and diaphragm by thick false membranes of recent formation. On the left side the attachments were not so extensive, and the membranes were of still more recent growth. On each side there were thick masses of coagulated lymph, weighing from 2 to 3 pounds, and of a whitish color and firm consistency, which indicated

*Plates IV to XII inclusive are duplicates of the plates which accompany the report of Dr. Salmon in the First Annual Report of the Bureau of Animal Industry, and are similarly numbered.

their formation a number of days before the death of the animal. The lung tissue presented no signs of hepatization.

The second cow examined was brought to the Station over two months before, and at the time of this examination was somewhat emaciated. She was coughing when first seen, had little appetite, and an examination of the lungs showed dullness and loss of respiratory murmur over the lower part of the right lung.

Three animals had previously been lost in the stable from which she came, and before death they presented symptoms of lung disease.

This cow was slaughtered, and on opening the cavity of the thorax the left lung was found adherent to the diaphragm and the right lung to the costal pleura. The right lung contained four or five masses, varying from two to four inches in diameter, surrounded by a thin cyst wall and composed of hepatized lung tissue in a disintegrating condition.

The third animal, which was also somewhat emaciated, was obtained January 10, from a stable where two cows had been lost in the preceding summer. She had been purchased for $50 two or three months before she sickened, and was at that time in good health. When brought to the Station her temperature was 104° F., and there was complete dullness and loss of respiration over the left lung. Her condition was substantially the same on the day of examination, January 12. When, after slaughter, the ribs of the left side were removed, a considerable quantity of amber-colored liquid escaped. This lung was completely hepatized and solidly attached to both the ribs and diaphragm. A section of the lung disclosed the interlobular tissue distended with lymph, though not to the degree sometimes seen. There was, however, a very distinct marbled appearance, and a difference of coloration between the upper and lower parts of the lung that probably resulted from a difference in the age of the hepatization in these two portions. The right lung of this animal was in a normal condition.

A fourth cow was obtained from a Washington stable the same day that the above examinations were made. She died during the night of January 12. Her appearance before death and the condition of her lungs when examined were very similar to that of the third cow mentioned above.

May 1, 1884, a sick cow was reported at Miss Fannin's, on M street, in this city. She was examined the same day and found to be moaning with each expiration; her breathing was labored; there was salivation, extended head, and elbows turned out. The bronchial breathing was loudest on the right side; the left side was very dull on percussion up to and somewhat above the median line. The right side had a dull area at lower portion of thorax and another above the median line.

May 5, this animal, now sinking rapidly and already tympanitic, was slaughtered. The autopsy revealed the left lung completely solidified with the exception of a very small part of the anterior lobe. Various stages of inflammation were to be seen in the different parts of the lung. There were thick false membranes and solid adhesions to the diaphragm and costal pleura. The right lung was extremely emphysematous, and parts of it adherent to the costal pleura, but there was no hepatization of its tissues.

CONNECTICUT.

In the latter part of August, 1883, I investigated an outbreak of disease at Salem, Conn., which had affected cattle on the farms of H. E.

Williams and Captain Seaman, of that place. The history of this outbreak may be summarized as follows: Hon. E. H. Hyde, of the State Commission on Diseases of Domestic Animals, first visited the farm of Mr. Williams on August 8, and at that time found a young bull in the lot partially recovered from an attack of disease, and a cow and an ox were both very sick with what he considered to be the typical symptoms of pleuro-pneumonia. At Captain Seaman's a cow was very sick and presented the same symptoms as were seen with the affected cattle belonging to Williams.

The next morning Dr. Rice, of Hartford, was called, and on arrival, Williams' cow was found to have died during the night.

A *post-mortem* examination was made and the lung found attached to the walls of the chest; when cut across it was seen to be solidly hepatized, of a marbled appearance, and presented all the characters of contagious pleuro-pneumonia. The Commission advised slaughter, which was objected to, but the same day, after the departure of the State officers, the sick ox belonging to Williams and the cow belonging to Seaman were slaughtered. These animals were not examined professionally, but the descriptions which I received from those who were present were sufficient to satisfy me that the lungs were solidified and attached to the ribs.

August 29, I visited Mr. Williams' farm and learned from him the particulars of the outbreak. The first symptoms of disease were seen in one of the cows June 20, and a second cow was attacked on June 23; both of these died from the effects of the disease July 3. At the time of my visit, August 29, there were six animals on the place: one ox, quite sick, with left lung solidified; one Jersey cow, had been quite sick but was now better; one young Jersey bull, with left lung solidified, and three Jersey cows, in which I found no evidence of disease. Only one animal had been brought on the place within a year preceding the outbreak, and that was a Jersey cow named Mollie Lathrop 3d, No. 7627. She was obtained by exchange with Charles Decline, of New Durham, N. J., on April 10, 1883. This cow aborted the last of May, but has shown no other signs of sickness. At the time of examination she was in fine condition, fat, glossy, with no cough and no signs of lung disease, revealed by either auscultation or percussion.

I visited Charles Decline at New Durham, N. J., on August 30. He stated to me that he exchanged cows with Williams about April 16. His cow went to New London on the same boat that the other returned by. According to the statement of Williams' farmer, the two cows were together about a quarter of an hour at New London. The cow Decline received from Williams sickened about the last of May. About a week later she and another Jersey cow, which stood beside her, and which was also sick, were killed and examined by his son, who is a veterinary surgeon. Both were affected with lung disease, which he pronounced to be pleuro-pneumonia. The lungs were hepatized, marbled in color, and attached to the walls of the chest.

Decline purchased Mollie 3d of Mr. Whitenack, of Dunellen, N. J., December 13, 1881. He says that he never had any disease among his cattle until after the cow arrived from Connecticut, and attributes the infection to her.

It was evident that some of the facts connected with the history of the disease in these two herds had been concealed, but it was very certain that the disease had existed in both herds, and it was very probable that one of the herds had been infected as the result of the exchange referred to above. Considering that there had been no disease in Con-

necticut until nine weeks after the exchange, and that it was admitted to have existed in Decline's herd four weeks earlier than it appeared among Williams' cattle; and considering, further, that the vicinity of New Durham has long been infected with pleuro-pneumonia while none had previously existed in the neighborhood of Salem, and the probability is that the disease was carried from New Jersey to Connecticut. There is one other possibility, however, viz., that both cows were infected on the boat or between the boat landing and Decline's place.

This theory is not probable, for the reason that a second cow was sick at Decline's by the last of May, and this would require the assumption that two full periods of incubation had elapsed between April 16 and May 30; that is, within six weeks. Now, it is very seldom that the period of incubation of pleuro-pneumonia is less than four weeks, and it is generally longer than this; consequently, it is very unlikely that in two successive cases on the same farm it would be reduced to three weeks. The admitted fact that both sickened at about the same time is an indication that both were infected at the same time, and from a common source, rather than that one contracted the disease from the other.

A second visit was made to the farm September 7, in company with Hon. E. H. Hyde and T. S. Gold, of the State Commission on Diseases of Animals, and Doctors Thayer, Rice, and Parkinson. At this time the bull and ox still presented symptoms of pleuro-pneumonia. The cow, Mollie 3d, was again carefully examined and showed a rather large area of dullness over the region of the heart and another low down on the right side. My own opinion was that this dullness did not indicate any disease of the lungs, though some of the others thought differently. It was admitted by all, however, that there were no positive signs of diseased lungs in her case.

A third visit was made, in company with the same gentlemen, with the exception of Dr. Thayer, September 12, when the ox mentioned above was slaughtered and examined. This animal was now believed by the owner to have recovered. The autopsy revealed the left lung solidly attached over a large surface to the thoracic wall and diaphragm. One-third of the organ was encysted and beginning to disintegrate, another third showed more recent hepatization and was not yet encysted. A section showed the characteristic marbled appearance, and the difference in the age of the inflammatory process in various parts of the lung.

Members of the State Commission have since informed me that the bull continued to fail and was destroyed by the owner on the 27th of October. Before this, however, the Commission was called September 18 to see a new case of the disease, which had developed on the farm of Amos Williams, the second neighbor south from the originally infected premises. This was a cow, which presented the typical symptoms and *post-mortem* appearances of pleuro-pneumonia, having been condemned and killed by the Commission.

To recapitulate: H. E. Williams had seven animals affected out of his herd of nine by the introduction of the cow from New Jersey, which animal was so slightly diseased as never to attract attention. Of the seven sick ones three died of the disease. Two of those slaughtered probably could not have recovered; one of the slaughtered oxen was improving, while the remaining cow was very sick when I last saw her. The adjoining farm on the north and the second one on the south each lost one animal from the disease. There were, consequently, nine animals affected in this outbreak.

PENNSYLVANIA.

October 3 and 4 I visited Chester County, Pennsylvania, in company with Mr. T. J. Edge, special agent of the governor, and Dr. Bridge, State Veterinarian. On the farm of W. P. Thomas I witnessed the slaughter of 3 cows, and on the farm of J. H. Garret I saw 5 others killed, these having been condemned by the State authorities as affected with contagious pleuro-pneumonia. The autopsies revealed the existence of a very similar condition in each of the animals. In most cases a whole lung was hepatized and firmly attached to the diaphragm and ribs. In several of the animals both lungs were affected. The pleural cavity contained large quantities of straw-colored effusion, and the connective tissue of the lungs was excessively distended with exudation of a similar liquid. The inflammation was very plainly of a progressive character, and the marbling of the lung was as distinct as in any cases I have ever seen.

The disease was introduced into this section by a car-load of 14 cows brought by John Noble from Baltimore. Where these cows were originally infected is a contested point between the authorities of Pennsylvania and those of Maryland; but there is no reason to doubt that the outbreak near West Chester was caused by this lot of animals.

These cows were sold as follows: July 19, to W. H. Shepherd, 1; July 26, to W. P. Thomas, 3; July 26, to H. Euches, 4; July 27, to J. H. Garret, 2; August 1, to J. Kelly, 2; not traced at time of report, 2.

Mr. Shepherd's cow was found sick with symptoms of pleuro-pneumonia September 8, and slaughtered by the State authorities. The autopsy revealed the characteristic lesions of lung plague. September 13 a cow was found affected with the same disease and slaughtered on Mr. Garret's farm. September 29 it was necessary to slaughter one of Mr. Thomas' cows. October 1 it was found that two cows had already died on Mr. Euches' farm, and that six others were sick.

According to information received from Dr. Bridge, October 23, 1884, the number of cattle exposed and slaughtered on account of sickness was as follows:

Owner.	Number exposed.	Number killed.
W. P. Thomas	42	42
Homer Euches	29	12
J. H. Garrot	33	14
W. H. Shepherd	1	1
Total	105	69

Eight adjoining herds were infected by the above, as follows:

Owner.	Number exposed.	Number killed.
W. H. Pratt	17	6
M. S. Garrett	11	3
E. J. Lewis	15	5
C. Smedley	22	2
Geo. P. Hughes	20	8
W. F. Dutton	16	16
W. Evans	5	1
L. V. and W. E. Smedley	21	9
Total	127	50

The affected cows which I saw were native animals in good condition. They had excellent pastures to run on, and there was no local cause whatever which could be suspected of producing this or any other disease. Besides, the time of year was not one in which acute lung diseases are seen among cattle. Nearly every one of the affected lungs which I saw when in this State showed the typical lesions of pleuro-pneumonia so plainly that, according to the best authorities in the veterinary profession the world over, any one of them would have been sufficient to afford a safe basis for diagnosing the disease.

Besides the herds infected by the contagion introduced with the lot of cattle from Baltimore, six herds have been infected from other sources since September, 1883. The following table shows the number exposed in each of these and the number destroyed after showing symptoms of the disease:

Owner.	Number exposed.	Number killed.
F. Carr	3	1
W. Williamson	5	2
F. Galloy	20	14
—— Heisey	9	5
—— Myers	17	2
J. Noble	10	0
Total	64	24
Total in preceding tables	232	119
Total for State of Pennsylvania	296	143

NEW JERSEY.

Dr. Rowland, an Inspector of this Department, stationed at Jersey City, N. J., discovered during the summer of 1883 that animals affected with pleuro-pneumonia were being shipped to New York from Hunterdon County, New Jersey. An investigation was ordered by Dr. E. M. Hunt, secretary of the New Jersey State board of health, and a number of herds were found in Hunterdon County which had been for some time affected with this disease. Owing to the fact that the owner of the affected herds was a large cattle dealer who gathered up cheap animals from various parts of New Jersey and Pennsylvania, and to the additional fact that the disease had been upon his premises for an indefinite time, the origin of the trouble could not be satisfactorily traced.

The owners of the infected herds had resorted to inoculation to arrest the progress of the disease, and it was said that all fresh animals which arrived were speedily inoculated. In spite of this, however, the losses were very heavy, though their full extent could not be ascertained. Dr. Miller, who investigated the condition of these animals, November 1, informed me that out of one herd, containing 60 head, 22 had been lost; from another containing 65 head, 8 were known to have died, and 1 was killed to obtain virus for inoculation; from another, containing 46 head, 8 had died; from a fourth, containing 70 head, 10 had died; and from a fifth, 6 had died. There had, consequently, been at least 55 deaths; in addition, a certain number had partially recovered, and some diseased animals had been sold.

According to the best information we could obtain the total number of cases of pleuro-pneumonia which had occurred in this county was not less than 100. These herds were quarantined and the State authorities are doing everything possible with their limited appropriation to

stamp out the disease; but where so many animals have been exposed, and where the contagion has been sown broadcast over the pastures of half a dozen farms, experience shows that it is next to impossible to remove all danger except by killing all animals exposed and quarantining the farms for a long time.

MARYLAND.

Owing to the variety of reports in regard to the existence of pleuro-pneumonia in Maryland, Dr. Rose was directed to proceed to Baltimore during the last week of October, 1883, and examine a sufficient number of stables to form a basis for conclusions in regard to the distribution of the disease in that section. The cases of sickness mentioned are only those in which the symptoms indicated pleuro-pneumonia. The following is a list of stables in the order in which they were examined, with a condensed summary of the information obtained:

Stable No. 1: Contains thirty-five cows. One chronic case, two recent deaths.
Stable No. 2: Thirteen cows. No disease.
Stable No. 3: Sixteen cows. One chronic case, two recent deaths.
Stable No. 4: Seven cows. No information.
Stable No. 5: Nineteen cows. Admit that cows are exchanged as soon as they show signs of disease.
Stable No. 6: Nine cows. Three recent deaths.
Stable No. 7: Two cows. Admits recent deaths from lung disease.
Stable No. 8: Thirteen cows. Two recent deaths from acute lung disease.
Stable No. 9: Seventeen cows. Have lost many in the past. All are now well.
Stable No. 10: Eighteen cows. Have lost two during the summer.
Stable No. 11: Nineteen cows. Would neither allow an examination nor give information.
Stable No. 12: Seven cows. None sick. No information.
Stable No. 13: Eleven cows. None sick.
Stable No. 14: Fifty-six cows. One acute and four chronic cases of pleuro-pneumonia. Have lost heavily in past years.
Stable No. 15: Eighteen cows. Five sick with acute lung disease within two months, of which three died.
Stable No. 16: Forty-two cows. Acknowledge a loss of over 200 cows from lung disease within three years. Several now coughing.
Stable No. 17: Fifty animals. No disease.
Stable No. 18: Thirty-six animals. No disease.
Stable No. 19: Original herd 12 animals. Three died during September and October. Calf died in October which State Veterinarian examined and pronounced affected with pleuro-pneumonia. Three still sick with same disease. First cow to sicken came from another stable in Baltimore within a few weeks.

The herds in the nineteen stables referred to above contained 398 animals, of which 12 were found to be sick or only partially recovered at the time of inspection; 3 cows had recently been exchanged while sick, and 18 recent deaths had occurred. The total number of animals which had recently sickened with symptoms of pleuro-pneumonia in the above stables was, consequently, 33, or 8.3 per cent.

This inspection, while it cannot be taken as a very accurate indication of the proportion of the Baltimore dairy cattle which are constantly affected with pleuro-pneumonia, is nevertheless sufficient to show that a very large proportion of the stables are infected, and that many cases of the disease occur.

A considerable number of inoculation and cohabitation experiments have been made and are still in progress, and will be given in detail in the First Annual Report of the Bureau of Animal Industry.

THE OUTBREAK OF PLEURO-PNEUMONIA IN THE WEST.

On the 15th day of July, 1884, Dr. Trumbower was requested to visit a cow at Sterling, Ill., belonging to Mr. C. A. Keefer. He found one of his thoroughbred Jersey cows, aged about six years, with the following symptoms:

The skin was abnormally dry and dead-looking, the animal standing with the head extended and the ears slightly drooping, coughing frequently and protruding the tongue. The character of the cough was dry, harsh, and rather weak, but not very painful. The eyes were bright and prominent, respiration 50, pulse 94, weak but regular, temperature 103.8° F. Auscultation on the right side of the chest revealed a subcrepitant sound immediately behind the shoulder, a little below the median line. In the middle and superior regions the respiratory murmur was slightly augmented; percussion elicited a trifling dullness over the lower third of the fourth and fifth ribs. In other parts no abnormal sound was produced, with the exception of a slightly-increased resonance over the middle and superior regions. On the left side a loud murmur or sonorous rhonchus was heard in the median region behind the shoulder, accompanied by a dry and soft rubbing sound; below this part no respiratory murmur was audible, but in the act of coughing a gurgling or splashing sound was heard as that of a liquid being suddenly agitated in a cavity. Percussion revealed dullness over the central and lower posterior portions of the lung. No abnormal sensitiveness was manifested by pressure being applied along the spine or percussion over the chest. The history of this case is as follows:

Mr. Keefer saw this cow, Lass O'Lowrie, on the stock-farm of W. C. Clarke, Geneva, Ill., on the 6th day of April. At the same time he also saw there two other cows, Tama Warren and Nutrina of Tunlaw; all three had the appearance of unthriftiness, the hair looking rough and dry, but this was attributed to a severe winter without proper care, and, in the case of Lass O'Lowrie, to recent calving. On the 6th of June Mr. Keefer bought the latter animal from Mr. Clarke upon the representation that she was perfectly healthy. She was shipped on the 8th, and was four hours in transit. When Mr. Keefer took her from the car and drove her to his place she coughed frequently, and her hair looked bad. She was thin in flesh and yielded no milk. She calved some time in March and was again pregnant. From this time on she gradually became poorer and weaker. The milk secretion remained entirely suspended. She stood in the field away from the other cattle, and usually rested on the right side when in a recumbent position. Rumination was entirely suspended, appetite capricious, cough increasing in frequency, and had paroxysms of almost incessant coughing, lasting in the early morning for an hour or longer; nose alternately moist and dry; occasionally a string of mucus would be noticed to drop from the nostrils; the cough became more painful and the tongue was protruded in the act; frequent grating of the teeth was heard; no irregularity of the pulse or tympanitis was noticed; no arching of the back or turning out of the elbows; no moan or grunt accompanied respiration; no rusty colored and no discolored expectoration was coughed up. The case was thought to be one of tuberculosis, and isolation was recommended, and slaughter and burial as soon as he could decide upon the necessity of the measure. He was requested to give notice and allow a *post-mortem* examination to be made when she was slaughtered, or in case she should die. On the morning of the 24th she was bled to death. On examination, the anterior lobe of the right lung was found filled with tubercles covering

a space 4 inches in diameter; they presented different stages of development, some containing a thick yellow or inspissated pus, while others were undergoing a caseous degeneration or calcification, and still others appeared as small, indurated, brown, or reddish, circumscribed spots in the interlobular tissue. There was very slight adhesion between the visceral and parietal pleura at the inferior and anterior extremity of the right lung; the superior and posterior four-fifths of the right lung was apparently healthy; on the left side there existed extensive adhesion of the posterior lobe of the left lung to the side of the chest and diaphragm, implicating almost the whole of the adjacent side of the pericardium; a large amount of firm gelatinous exudation and strong fibrous bands united the inferior, posterior, and central portions of the posterior lobe firmly to the pericardium, diaphragm, and costal pleura; no abnormal effusion was present in either side of the chest; no indications of the recent affection of the pleura were seen; the anterior lobe of the left lung contained numerous tubercles and abscesses from the smallest visible size to half an inch in diameter; many tuberculous nodules coalesced so as to form large irregularly-shaped masses; in the posterior lobe, beginning at the bifurcation of the trachea and extending downwards and backwards, was discovered a cavity 10 inches in length, which contained a pint of fluid of a grayish-black color of very offensive odor, holding in suspension disintegrated lung tissue; also in this cavity was discovered a mass of infarcted, necrosed lung tissue, weighing 2 pounds; the part nearest the right lung was breaking down and liquefying. Another mass of dead lung, weighing 4 ounces, of a yellow, granular, or caseous appearance, indicating that it was much older than the larger mass, was found lying in and partially buried in a separate sack which communicated with the larger cavity. The mass of infarcted necrosed lung on section presented a reddish-brown appearance, and the lobules were distinctly outlined as well as the remains of the larger blood-vessels and bronchi. The walls of the cavity were composed of fibrous tissue one-quarter inch thick, and remains of blood vessels extending into and across the cavity. The antero-superior portion of the right lobe of the liver presented one compact mass of tubercular nodules, and throughout the central parts of this organ numerous tubercles were seen. One measuring 2 inches in diameter was located at the transverse fissure, and was undergoing calcification. In the abdominal lymphatic glands there were masses of compact tuberculous matter encysted in strong fibrous capsules, one of which measured 3 inches in diameter. Nearly all of the tubercles presented a bright yellow color on section, and but few gray tubercles were seen, and then only in the lung tissue.

Dr. Trumbower sent parts of the lungs and liver of this animal to Washington for my examination. The cow had evidently been affected with tuberculosis, but the encysted mass of dead lung was a lesion which is not produced in this disease, but which is a frequent result of contagious pleuro-pneumonia. It seemed possible, therefore, that the two diseases might have existed at the same time in this animal, though the fact that we knew of no pleuro-pneumonia in that section of the country made the presence of this disease appear very doubtful.

On investigating the condition of affairs at Mr. Clarke's farm it was learned that his animals had been suffering from a disease that had caused the death of several during the spring and summer. A cow which had been sold to C. P. Coggeshall and taken to the farm of Mr. John Boyd, of Elmhurst, was very sick, and a second cow bought by Mr. Boyd was also sick. On the 12th of August I visited Mr. Boyd's

place, and found that the cow called Cream Ecca, belonging to Mr. Coggeshall, had died the 20th of July; that the cow Edith St. Hilaire had improved very much during the past two weeks, and was then believed by her owner to be nearly well. Another cow, called Dessie 4th, belonging to Mr. Boyd's herd, was very sick. This animal was suffering from acute lung disease, with complete dullness and loss of respiration over the right lung, and dullness over the lower part of the left side of the thorax. Her temperature was 105° F. An examination of Edith St. Hilaire revealed dullness and loss of respiratory murmur over the posterior part of the right lung. An examination of Cream Ecca had been made by a local physician, who pronounced her affection to be consumption, and called the changes which he saw in the lung tissue caseous degeneration. A piece of this lung tissue, which was secured and shown to me by Dr. Trumbower, was hepatized as in pleuro-pneumonia.

These facts appeared sufficient to justify the diagnosis of contagious pleuro-pneumonia, but in the absence of any history beyond the Clarke herd, and considering the fact that the only cow of which a careful *post-mortem* examination had been made was certainly affected with tuberculosis, it seemed best to reserve a decision until more complete evidence had been obtained. In regard to Cream Ecca, it was said that her sickness came on soon after calving, which occurred July 2; that she retained the afterbirth and failed from that time. Two or three days later the afterbirth was removed by force and she commenced to sink rapidly and died July 20. The autopsy was not made until two days later. There was consequently some reason for thinking that her lung disease might have been the result of septic infection as a consequence of the forcible removal of the afterbirth. In regard to Dessie 4th, it was said that she had been tied by one of the farm hands to a wagon in the lot where she had been exposed to a cold rain and had undoubtedly suffered in consequence. It was believed by her owner that this exposure had aggravated, if it had not caused, her disease. In regard to Edith St. Hilaire, it was thought that she might have taken cold, and there were some indications that she had a tendency to tuberculosis. Taking all these facts into consideration the only safe course appeared to be to make further investigations before deciding as to the nature of the disease, and I urged Mr. Boyd to allow the slaughter of one or both of his sick animals; this he willingly consented to do, but it was now so late in the afternoon that we postponed the slaughter until the following day. On visiting the farm August 13, I found Mr. Boyd somewhat undecided as to whether he ought to allow the slaughter of his valuable animals for examination without further evidence that they were affected with a contagious disease. While discussing the matter one of the Chicago newspapers was received which contained a sensational article announcing the outbreak of contagious pleuro-pneumonia among Mr. Boyd's cattle, and a few minutes later two reporters appeared, who had been sent to make an investigation. It was now thought best to delay the slaughter and examination until the following morning, when this could be accomplished in quiet and without undue publicity. In the mean time arrangements had been made to isolate the sick animals from the remainder of the herd, and two cows which had shown loss of appetite and an increased temperature without any perceptible lesions of the lungs were also placed by themselves. On the morning of August 14, I made a third visit to Elmhurst, and in the presence of Mr. J. H. Sanders, member of the late Treasury Cattle Commission, Mr. Wadham, and Mr. Boyd, the two sick cows were

slaughtered. An examination of the lungs of Edith St. Hilaire showed the posterior half of the right lung to be adherent to the ribs and diaphragm. The whole posterior part of the lung was inclosed in a fibrous cyst, the lung tissue being hepatized, of a reddish color, but still intact and firm. The median part of the left lung was in the same condition. With Dessie 4th the inferior and posterior parts of the right lung adhered by thick false membranes to the ribs and diaphragm. There was an abundant effusion of straw-colored liquid in both sides of the chest. Two-thirds of the right lung was hepatized, the thickened interlobular bands being distended with exudation liquid. There was plain evidence from the color and appearance of the different parts of the lung that the inflammation had been of a progressive nature, and that some lobules had been invaded much later than others. The left lung was covered at its posterior border with thick, white, false membranes; these were also seen over its anterior lobe; there were blood discolorations of the pleura and signs of hepatization in its earliest stage. In this case the intensity of the inflammation, the amount of lung tissue involved, the progressive nature of the inflammation, and the marbled appearance of the lung made it impossible to hesitate longer in concluding that the disease was contagious pleuro-pneumonia. It was in every respect a typical case of this disease.

Mr. Boyd had been informed at my first visit that the disease was probably pleuro-pneumonia, and that he should at once take every precaution to prevent the infection of other animals, both in his own herd and in the herds of his neighbors; and he was informed as soon as the examination of two animals was concluded that there could no longer be doubt as to the nature of the disease, and that it would be necessary to take every possible precaution to prevent its spread.

August 15 I went to Geneva, Ill., and examined the condition of the animals that were still on Mr. Clarke's farm. Mr. Clarke informed me that the first animal which showed signs of disease was the bull Finis Lawrence, which became sick during the latter part of May and was killed in June. The cows Ella Lawrence, Duchess of Broome County, Myrrhine, and Damask all showed signs of sickness about the middle of June. Ella Lawrence was killed with the bull; Duchess of Broome County died. Myrrhine and Damask recovered, and were on the farm at the time the examination was made. Tama Warren had also been killed, and Mr. Clarke insisted that this was because she was worthless as a breeder. Six animals in all had been killed or had died on Mr. Clarke's place since May. According to accounts received from other sources it is probable that Tama Warren and Nutrina of Tunlaw were sick as early as April 6.

At the time my examination was made Damask and Myrrhine were both in very good condition, showing more flesh than one usually sees with Jersey cows. Their hair was smooth and glossy, and, externally, they presented every appearance of perfect health. My examination was made in the pasture field, where, owing to the wind and the disturbance caused by flies, it was not as satisfactory as was desirable. At this time the lungs of Damask showed no signs of disease. Myrrhine showed dullness and loss of respiration behind the right shoulder. Two other cows in the herd and two bulls presented more or less evidences of lung disease, but this was not sufficiently marked to allow a positive conclusion as to its cause. One cow was evidently affected with tuberculosis. Mr. Clarke had brought on his place since June 1 one animal from New Jersey, three which he had purchased at the Epler sale at Viginia, Ill., one from C. A. Keefer, of Sterling, Ill., and

several from Wisconsin. It was impossible to judge from any information which I could obtain from him in what manner the disease had been brought to his place. As Ella Lawrence had come from Peoria, and as I heard rumors of disease at that place, I decided to make my next investigation there.

August 16 I called on Messrs. D. H. and S. S. Tripp, and on Mr. O. J. Bailey, at their offices in Peoria. These gentlemen at once admitted that they had lost animals from some disease, the nature of which they did not understand, and they freely placed at my disposal all the information which they could obtain bearing upon the matter. It was here that I gained my first insight into the history of the introduction of the disease into Illinois, and I am greatly indebted to Mr. Bailey and to Messrs. Tripp for the valuable assistance which they gave me. The first cases of this disease occurred in the Tripp herd, and they assured me that the only animals that had been brought upon their place for several months before this sickness were three cows purchased at the Virginia sale, which occurred February 21. These cows were Helena Rex, Albert's Pansy, and Fancy Le Brocq. These animals when first brought from Virginia were taken to Mr. Tripp's stable in Peoria, and afterwards Helena Rex was taken to his farm, which is situated about two miles from the city. I have been told by people who were at the Virginia sale that Helena Rex was coughing at that time and did not appear to be in good health, but Mr. Tripp either did not notice this or was not impressed with the idea that she was affected at all seriously. The first cow that presented unmistakable evidences of disease was Pomare, a cow kept for family use in the town stable. The earliest symptoms were noticed with her about the first of April, and she died April 17. She was treated by the veterinary surgeon for lung fever, but she had previously been a good, healthy cow. Helena Rex aborted April 25, and within three or four days became sick and was treated for inflammation of the womb. She had a cough, but after a few weeks apparently recovered. When I examined her, August 17, there was dullness over a portion of the right lung and a creaking sound heard on auscultation. This lung had evidently been extensively affected, and a considerable part of its tissue had been destroyed by disease. No other cases of disease occurred until July 12, when the cow Anna's Orphan presented the symptoms of inflammation of the lungs, and died July 27. The next case occurred July 25. It was a cow called Queenette, which died August 4. A *post-mortem* examination showed extensive inflammation of the lungs and pleura. The last case which had occurred at that time was a calf, daughter of Pomare, which died August 13 after a short sickness. An examination after death left no doubt that the disease was inflammation of the lungs and pleura. All of these animals had been taken down suddenly with an acute disease, which rapidly ran its course and terminated fatally. I was assured that there had been no disease of this kind among their cattle, nor among any other cattle in the vicinity, so far as they knew, previous to the purchase of the three animals at Mr. Epler's sale.

The first sickness in Mr. Bailey's herd occurred with a cow called Lady Florentia, which had been in his stable in Peoria up to May 10, and was then taken to his farm 7 miles in the country. This cow had not been in actual contact with any of Mr. Tripp's cattle, and the only way in which the disease could be accounted for in her was that it had been carried by some person going from one stable to the other. She showed no signs of disease until about the middle of June. Her trouble was thought to be indigestion. She milked less than usual, but still gave

so much that she could not be dried up. She was sick about three weeks, but was in pasture and had a fair appetite all the time. When I examined her, August 16, she still had a bad cough. There was dullness over the anterior and inferior portion of the right lung, with partial loss of murmur and a whistling sound. At that time she was said to be improving in appearance, her eyes were bright, her coat smooth and glossy, and her external appearance was that of good health. The second animal to become sick was Lechene. She showed the first symptoms about the 20th of June. There was loss of appetite and milk, fever, difficult breathing, and cough. She died August 8, and examination showed the right lung solid and red, greatly enlarged, and was described as looking like liver; it was adherent to the ribs and covered with false membranes. The third cow to sicken was Champion De Pansy. The first symptoms were seen August 11 or 12. August 16, when I examined her, there was dullness over both lungs, loss of respiration on the right side, labored breathing, and a temperature of $105\frac{2}{5}$° F. August 18 this cow was killed for examination, in the presence of Dr. J. H. Rauch, secretary of the State board of health, Dr. N. H. Paaren, State veterinarian, both of whom I had invited to be present in order that they might see the disease and be convinced of its nature. An examination revealed the right lung adherent to the costal pleura throughout its whole extent, and also firmly attached to the diaphragm; the false membranes were yellowish-white in color, and from one-fourth to one inch in thickness. Two gallons of yellow effusion surrounded the lung. The lung tissue was nearly all hepatized, marbled in appearance, with interlobular connective tissue distended with exudation; the pericardium was thickened and covered with false membranes. The left lung was not hepatized, but it was congested throughout, and the pleura was covered with delicate, false membranes, which were solidly adherent to the costal pleura.

Disinfection was commenced at once at both of these places, and every measure has been taken to prevent the extension of the disease. The cow Lady Florentia was a very valuable animal, but I informed Mr. Bailey it was necessary for the safety of his herd that she should be slaughtered. This has since been done, and I learn that her owner was fully satisfied, from an examination of her lungs, of the importance of this measure. The information which I obtained here made it seem very probable that Mr. Clarke had introduced the disease on his place also with animals purchased at the Epler sale. He received from there the cows Midnight and Nutrina of Tunlaw, and with these was shipped to his place Ella Lawrence, a cow that was sent to the sale at Peoria by Mr. Tripp. According to the best information I could obtain, Nutrina of Tunlaw was the first cow to sicken on Mr. Clarke's farm, and she doubtless was the means of infecting his other animals. The Virginia sale was quite a large one, and animals from it had been sent to a large number of places in different Western States.

The condition of affairs now seemed so very serious that I returned to Chicago, and, with your approval, issued the following circular:

DEPARTMENT OF AGRICULTURE,
Washington, August 20, 1884.

To the Cattle-Owners of the United States:

Owing to the existence of a disease supposed to be contagious pleuro-pneumonia in several herds of Jersey cattle in the State of Illinois, I hereby request owners of all herds of Jersey cattle in the United States, into which new animals have been introduced since January 1, to stop shipments of cattle until after October 1. The disease seems to have been introduced by animals sold at Virginia, Cass County, Illinois, in

February, 1884, and these animals were widely distributed through the Western States. It is hoped, therefore, that persons owning cattle tracing to this sale, and all others having cattle affected with disease of the lungs, will at once communicate with Dr. D. E. Salmon, Chief of the Bureau of Animal Industry, care of the Breeders' Gazette, Chicago, Ill., and clearly state the condition of their herds and symptoms of the disease.

The attention of owners of cattle and railroad and other transportation companies is called to section 7 of the act establishing the Bureau of Animal Industry, which makes it a misdemeanor, punishable by a fine of not less than $100 or more than $5,000, or by imprisonment of not more than one year, or both, for shipping cattle affected with any contagious, infectious, or communicable disease, and especially the disease known as pleuro-pneumonia, from one State or Territory into another. The cordial co-operation of State authorities and of all persons interested in the welfare of our cattle industries is earnestly desired in order to avert this danger which now menaces the herds of the country.

GEORGE B. LORING,
Commissioner of Agriculture.

August 22 I visited Mr. Epler's place at Virginia, secured a complete list of the animals which he had sold on the 21st of February, and made an examination of the remainder of his herd. I found no animals there showing any symptoms of pleuro-pneumonia, and Mr. Epler informed me that he had lost none from his original herd since the sale; but a cow called Jessie of Cloverside, which he had bought at Beardstown, Ill., and brought to his place in April or May, died in June of an acute lung disease, which, judging from the description of the appearance of the lungs that I received from him, must have been pleuro-pneumonia. A cow called Deerfoot, which was purchased by Mr. Bevis, of Virginia, at the sale, contracted pleuro-pneumonia and died in March. The description of the symptoms and appearance of the lungs was very clear and left no doubt of the nature of the affection. This animal had not come in contact with other cattle during her sickness. Another cow, called Jennie of Mapledale, was sold to Porte Yates, of Springfield, Ill. She was afterwards attacked with pleuro-pneumonia and died in April. I saw the owner of the cow and the gentleman who made the *post-mortem* examination, and their statements show that she had been affected with pleuro-pneumonia. Maud Holly was sold to E. S. Hodson, of Springfield, and soon after her arrival was treated for some slight sickness. When I examined her, August 22, she was looking well, but had a cough, with slight dullness and loss of respiration over the posterior part of the left lung. Mollie of Mapledale was sold to Frank Gaston, of Normal, Ill. She became sick April 6, a few days after having dropped a premature calf. She was supposed to be affected with lock-jaw, and no *post-mortem* examination was made. It is difficult to say at this time what really was the matter with this cow, but I am inclined to think from the history and symptoms of the case that it was one of pleuro-pneumonia, although no other animals in the herd contracted the disease. The cow Patalene was purchased by D. W. Rawlings, of Jacksonville, Ill., but he left her with Mr. Epler until April 2 or 3. She was afterwards sick, but there is considerable discrepancy in the various accounts I have received as to the character of her trouble and the time when she showed the first symptoms. Mr. Rawlings gave Dr. Trumbower a statement dated September 22, in writing, that he foundered her a little the first time he fed her, and that he called Mr. Rockwell to see her the following Sunday, and that this gentleman gave her medicine on Sunday and Monday and possibly on Tuesday; that she never was sick a day after that to his knowledge. Mr. Rawlings had previously written to me, under date of August 22, that he understood from inquiries recently made that his cow had been affected with lung fever. He knew she had a very bad cough and did not get over it for several

weeks. He stated that she still coughed once in a while for a few minutes at a time, as if she were choked. Charles Rockwell stated to Dr. Trumbower that his visit to treat the cow Patalene was on the 10th of May. He knew this from an entry in his book, but he fails to remember anything about her having been overfed. He stated that she had a very bad cough, and he diagnosed the disease as influenza. She recovered in about four days. Soon after that she was turned into Mr. Morrison's field to pasture. On the 10th of June a roan Short-horn cow belonging to Mr. Rawlings was taken sick in the field, and Mr. Rockwell treated her. He could not tell positively what ailed her, but she did not cough as bad as the Jersey cow. He treated her for a month in the stable of Rawlings, and accepted her in pay for the treatment. Mr. Rawlings said that she coughed very badly, and it seemed to hurt her very much. He thought she was taken sick ten days or two weeks after the illness of the Jersey. Mr. Rockwell turned this cow into the Morrison pasture for a while, and then took her to his own barn and kept her there until August 7, and she was killed for beef a few days later. Mr. Morrison had two cows in this pasture. One of them began to cough, and Thomas Scott was called to treat her on the 19th of June. She was sick and weak, though eating all the time, and thin looking; she protruded her tongue while coughing. Dr. Tiffany treated two cows in the adjoining field, which, he states, were affected with simple catarrhal fever. They recovered in a few days. Dr. Trumbower examined Patalene and a cow belonging to Mr. Morrison on the 18th of September, but failed to find any evidence of disease at that time. The cows Julia May and Jane Stoughton were sold to J. B. Warlow, of Danvers, Ill. He took them home a few days after the sale. Julia May was thin and looked bad when he bought her. She had a cough when she reached his place. In the month of June her cough became more frequent, and she lost flesh and strength; her breathing was very difficult, and she died on the 10th of July. They made a *post-mortem* examination and found one lung attached to the ribs and the covering coated with a "scum." This lung was double the weight of the other. In cutting across the solidified portion it had a marbled appearance. Jane Stoughton has never been sick nor even coughed. The cow Eva B. was sold to William Hanna, of Golden, Ill., who received her on the 23d of February. She coughed occasionally at that time, but no attention was paid to it. About one month after the purchase she became sick, refused to eat, and appeared dull and stupid. This continued for several days; she then aborted, and eight or ten days later appeared to be well again, with the exception of an occasional cough. She was examined by Dr. Trumbower in the latter part of September, and at that time presented no evidences of disease.

W. F. Whitson & Son purchased at the Epler sale the cow Pansy Lassie and the bull Andrew. I learned from Mr. Epler and others that Pansy Lassie had an attack of what was supposed to be pneumonia soon after she was received at Virginia. She was treated for this disease, and at the time of the sale was much improved, though the statement was made that she had recently been sick, and she was not sold as a perfectly healthy cow. Mr. Whitson did not understand that she had been sick with lung fever, and though she was thin in flesh he did not suspect any previous disease. Examined September 17 by Dr. Trumbower, she presented the most positive evidences of chronic pleuropneumonia. There was very extensive and probably complete hepatization of the left lung; only a very small amount of air entered the larger bronchi in the upper part of the lung and produced a whistling, blow-

ing sound at each expiration. The right side showed no marked symptoms of disease. This cow coughed every ten minutes or oftener when she was made to move. The cough was suppressed and shallow, and apparently accompanied by more or less pain. The bull Andrew appeared to be all right, but two or three other animals in the herd were beginning to cough. William Bell, of Miami, Mo., purchased eighteen head of cattle at the Epler sale. One of these, Zadie, was taken sick about the 12th of May and for ten days ate very little and had a cough. She was isolated, and after calving began to improve and was turned in with the other cattle. This herd was examined August 27 by Dr. Trumbower, when all the animals were found in fine condition, with no signs of pleuro-pneumonia in any. This completes the list of animals sold at the Epler sale, which our investigations show to have afterwards been affected with a disease having symptoms resembling those of contagious pleuro-pneumonia.

As very many of the cattle sold at the Epler sale soon afterwards became affected with pleuro-pneumonia, and as the mingling of the animals at this sale was the only means by which many of these herds could be connected, it became very certain that the disease in Illinois had been brought to that State with some animals that had been sent to Mr. Epler. The animals which he had collected for this sale had come from a number of different herds located at widely separated points. An investigation of the condition of these herds led us to believe that only one had been affected with pleuro-pneumonia. This herd belonged to Mr. C. R. C. Dye, of Troy, Ohio. On the 28th of December, 1883, Mr. Epler purchased five cows of Mr. Dye. The animals were shipped soon after, and arrived at Virginia January 4, 1884. These cows were Mollie of Mapledale and Jennie of Mapledale, both of which came from the herd of James Lyman, of Downer's Grove, Ill., in May, 1883; Fancy Le Brocq, which was bought at Kellogg's sale in November, 1883, and had come from the herd of D. A. Givens, of Cynthiana, Ky.; Albert's Pansy, from the herd of George V. Green, of Hopkinsville, in November, 1882—this cow had not been on Mr. Dye's farm since her purchase; Pansy Lassie had been purchased of John E. Hamilton, in November, 1882.

Mr. Dye informed me that he was in Europe at the time the disease broke out among his cattle. The first animal attacked was Rayon d'Or, a bull, which had not been away from his place since October, 1883. This animal showed the first symptoms some time in February, and died in March. A number of cattle in his herd were affected and some were killed, but he undoubtedly had two different diseases in his herd at the same time—a severe sore throat and pleuro-pneumonia—and it is now a difficult matter to determine which of the animals were affected with the sore throat and which had this in connection with the lung disease. Three calves were killed which Mr. Dye thought were only affected with the sore throat trouble, but Dr. Butler, who attended his cattle at that time, thought they also had lung disease. When I was at the farm I saw one of the animals affected with the disease of the throat, which was suffering very severely, but which had no signs of disease in the lungs. I feel confident, therefore, that Mr. Dye is correct in stating that some of his cattle were affected with disease of the throat only, but this makes it difficult at the present time to decide just how many cases of pleuro-pneumonia occurred in his herd. He lost, altogether, four animals which died and three which were killed previous to my visit. As soon as this trouble was discovered among his animals all sales were stopped, the sick animals were put by themselves

on a different farm; the stables were whitewashed and disinfected and every precaution taken to prevent the spread of the disease to other herds, and so far as we have been able to learn no animals in the vicinity of his farm have contracted the disease. An examination of his herd revealed the fact that a number of animals still showed positive evidence of lung disease. An effort was made immediately to raise sufficient money to purchase and slaughter the affected animals, but the discovery of another affected herd in the State destroyed all hope of obtaining sufficient funds for the purchase of all the diseased animals and thus freeing the State from the disease. Mr. Dye, however, was anxious to get rid of the disease in his herd, and consented to have those animals slaughtered which presented the plainest signs of the affection on condition that the State board of agriculture would recommend the granting of compensation at the next sitting of the legislature.

September 19 I selected seven animals which presented signs of lung disease, and these were appraised and slaughtered. The following is a brief statement of the *post-mortem* appearances:

No. 107.—Nearly all of the surface of the right lung attached to the ribs and diaphragm. The lung was one large cyst, in which the hepatized tissue was nearly all disintegrated and broken down into pus.

Bull.—Right lung adherent to ribs and diaphragm. A cyst 3 by 4 inches in diameter contained hepatized lung tissue badly broken down.

Sylvie.—Posterior portion of the left lung atrophied with fibrous degeneration and adherent to ribs and diaphragm.

No. 145.—Left lung adherent to ribs and diaphragm, encysted mass four inches in diameter containing disintegrated lung tissue.

No. 114.—Left lung slightly adherent to diaphragm and ribs, weighing 12 to 14 pounds, containing encysted mass of eight inches or more in diameter and weighing 8 to 10 pounds.

No. 142.—Both lungs adherent to diaphragm and ribs, atrophy and fibrous degeneration of one-third of left lung, two small and encysted masses of dead lung tissue.

No. 41.—Right lung largely adherent, atrophied with fibrous degeneration; in the pleural space between the lungs and slightly attached to the diaphragm was a large cyst full of purulent liquid and having the capacity of about one quart.

The remainder of the suspected animals were placed by themselves at a considerable distance from the others of the herd, and Mr. Dye consented to consider the whole place in quarantine until such time as I could declare all danger to be past.

Mr. Dye does not know how the disease was introduced into his herd. He had purchased a number of grade Jersey cattle in the vicinity of Baltimore and a large number of registered Jerseys from the herd of the late John W. Garrett, the of the same county, in November, 1883. The same month he purchased fifteen head of A. M. Herkness, of Philadelphia, a part at private sale, and a part at his auction. Two weeks earlier than this he had purchased a car-load of registered Jerseys at Kellogg's combination sale in New York. All of these cattle were shipped to his farm at Troy. I believe that the disease was brought with the grade Jerseys which had been gathered up in the vicinity of the city of Baltimore. I have been unable to find pleuro-pneumonia in any herds, so far as examined, from which the other cattle came, and it seems very evident that if the disease had existed in Mr. Garrett's herd or among any cattle at Herkness' auction, or at Kellogg's sale, it would have been carried to other places, and we should have found it in many other herds besides that of Mr. Dye and those which had

received cattle from him. It seemed probable that among the grade Jerseys there was one which had recovered from the acute stage of pleuro-pneumonia, and which, while appearing healthy, was still able to communicate the disease, as we know is the case with so many of the animals which make an apparent recovery from pleuro-pneumonia. Mr. Dye has only sold a very few animals since the time when the infection was probably introduced among his cattle. With a single exception, I have been unable to find that animals from his herd had carried the disease to other places besides the herd of Mr. Epler. This exception was a lot of three Jerseys sold by Dye to C. N. Mitchell, of Dayton, Ohio, and delivered about February 18, 1884. The introduction of these animals into Mr. Mitchell's herd has been followed by an outbreak of contagious pleuro-pneumonia, and he has lost seven animals from the disease. An inspection of his herd on September 4 showed that five additional animals had been affected, and still showed very evident symptoms. September 20 I examined two other cows belonging to Mr. Mitchell, one of which, an unregistered animal, had a slight crepitation and blowing sound in the right lung. It was my judgment that she had suffered from a mild attack of pleuro-pneumonia, and he informed me that she had been sent to his farm a month or more previous to be bred to his bull. She had been there but a few days when she was brought back to another farm several miles distant. The following is a list of the animals which died in his herd, with date of death: Doe's Blucher, April 27; Donna Daisy, May 1; Vivianetta, May 6; Rapier's Melville, May 28; one, name not known, died May 31; one, name not known, died June 2.

At the first examination of Mr. Clarke's herd we were informed that he had shipped eleven head of cattle in June to H. D. Frisbie, of Cynthiana, Ky., and that on August 9 nine other animals were shipped to the same party. When it became certain that Mr. Clarke's herd had been suffering from pleuro-pneumonia, I telegraphed to the honorable Proctor Knott, governor of Kentucky, under date of August 1, that H. D. Frisbie, of Cynthiana, Ky., had recently purchased twenty head of cattle from Clarke's herd at Geneva, Ill., stating that this herd was undoubtedly affected at that time with contagious pleuro-pneumonia, and that I had ordered a veterinarian to examine Frisbie's herd. In view of the enormous live-stock interests of the State, I recommended the prohibition of all movement of cattle from Frisbie's herd until after an examination of their condition was made. Owing to the fact that the first veterinarian asked to make this examination was unable to leave his practice, the examination of this herd was not made until August 29 and 30. At that time Dr. Trumbower made a careful examination of all animals which had been purchased from Clarke, and a number of others in the herd, and reported to me their condition under date of August 30. He was told by Messrs. Frisbie & Lake, who owned the herd of cattle, that they had purchased only fifteen head from Mr. Clarke, instead of twenty, as we had been previously informed. As there has since been a question in regard to the conclusions reached by Dr. Trumbower at the time of his examination, and especially in regard to information which he communicated to Messrs. Frisbie & Lake, I make the following summary of his report, which was written at Cynthiana the day the examination was made, and before any controversy had arisen, and consequently at a time when there could have been no reason whatever for stating anything but the exact truth. There were six calves, as follows: Nora Lawrence, temperature on August 30, 102.6° F., respiratory murmur entirely absent in left lung and complete consolidation

revealed on percussion. To account for this condition it was stated that this calf stuck fast in the mud of a pond and nearly suffocated. It was said to have always eaten, and to have shown no signs of sickness except a severe cough. It was more emaciated than the other calves; born some time in March. Floss Lawrence, temperature 104.6° F.; some consolidation in upper portion of the left lung; cough dry and frequent, with mucus and crepitant rales and dry, rasping sounds; born May 4. Flora Bronzo, temperature 103° F.; dry cough, white mucus discharge from the nostril. Fairy Bronzo, temperature 103.6° F.; no symptoms except cough. Cicero Sunbeam, strong mucus rhonchus. Fancy Cruiser, dry wheezing sounds, especially in left side; temperature 103.6° F. All cf these calves had been kept isolated in a pen and fed out of the same pail with a half gallon of skimmed milk twice daily to each calf. They were thin in flesh and all have a cough. They were placed in this pen on their arrival and have not been in contact with the older cattle. The following are the cows which showed signs of disease at that time: Flora St. Hilaire, temperature 103° F.; received from Clarke August 8; dullness over the upper part of right lung. Bell St. Hilaire, temperature 103.1° F.; received from Clarke August 8; did not detect any positive evidence of lung disease, but her breathing was more rapid than other animals in the same condition, and she had a suspicious cough. Flora Orange Peel, bought in Wisconsin in 1883; temperature, 102.5° F. Several small spots revealed dullness over the lungs and others an undue resonance on percussion. Sarah 1st, bought at a combination in New York in May; temperature, 103° F.; cough frequent, dry, and husky. Dora Mellwood, from the same sale; temperature, 103.4° F.; dullness over the lower half of eighth and ninth ribs of left side. Rissa Cicero, bred by Mr. Lake; temperature, 103.8° F.; had a harassing cough. Jessie St. Hilaire, purchased from Clarke August 8; temperature, 103.6° F.; cough dry and frequent; dullness over the lower half of the seventh, eighth, and ninth ribs on right side; pain evinced on pressure on intercostal spaces. Lorne D., received from Clarke July 1; temperature, 104.5° F.; troubled with cough. Many of the other cattle have a dry, husky cough. Frisbie & Lake state that the rag-weed is the cause of this, but it is my belief that many of the animals may be in the initial stage of pleuro-pneumonia. The seventy-one head of this number which were examined were pastured on 160 acres of blue-grass land, having plenty of water and shade. They were in good condition; their coats looked smooth and healthy, with a few exceptions. Frisbie & Lake stated that they had not had a sick animal on their place this season; that they had not sold any animals except twenty-two head which are to be delivered to Dr. Hamilton in the month of November. Dr Trumbower added:

I told Frisbie & Lake the condition in which I found all their animals, and strongly warned them against disposing of any of them. I told them that Flora St Hilaire, Nora, and Floss Lawrence were evidently afflicted with pleuro-pneumonia, and that several others were exceedingly suspicious. They, however, will maintain the assertion that none of them are diseased, and will abide their time to discover the true nature of the affection. I have good reason to infer from the conversation I had with Frisbie that if any of their stock become actually sick, they will quietly kill them or some accident will happen. They told me they would use every means in their power to remove all suspicion from their herd, and that if any injury was done to them as a result of the investigation they would hold the Government responsible. Mr. Lake thought he would refuse to allow you [Dr. Salmon] to make a second examination, as they were satisfied with the one I made, and that they, if they considered it necessary, would employ a veterinarian, or a number of them, to make examinations on their part, and that they would have to take a stand on the defensive. Mr. Frisbie wanted to make a compromise with me in this way: That if I would pronounce the

older cattle entirely free from disease, they would be willing to kill all of the six head of calves, but would not allow any *post-mortem* examination made of them; they would be willing to state that I had pronounced one of them suspicious, and therefore they, to insure safety, had killed the calves and removed thereby all danger of further contamination. I refused to enter into any such compact, but told them that I would report to you the exact condition in which I found their cattle, and that I would not express a positive opinion of the nature of the disease, although the actual condition of two of them, in connection with their history, would be sufficient grounds for a positive diagnosis without any great danger of mistake. They were going to send dispatches to the leading stock papers, making the statement as I made it to them, so there should not be any conflict between them and me, and went so far as to write it down. Nevertheless, after all that promise and seeming show of doing justice to us and to themselves, they forwarded dispatches stating that I found no disease in their herd and pronounced them all healthy.

The following correspondence, which explains itself, shows the action taken by this Department upon the receipt of the above report:

UNITED STATES DEPARTMENT OF AGRICULTURE,
Washington, D. C., September 13, 1884.

GENTLEMEN: I am informed by Dr. D. E. Salmon, Chief of the Bureau of Animal Industry, that twenty head of cattle purchased by you of M. G. Clarke, of Geneva, Ill., left that herd at a time when contagious pleuro-pneumonia existed in it. I am also informed that some of these animals now in your herd, when examined by Dr. Trumbower, an inspector of the Bureau of Animal Industry, showed very marked symptoms of this disease in its chronic form. Animals showing these symptoms are liable to infect others with which they may come in contact for an indefinite time after they have apparently recovered. I desire to inform you, therefore, that your herd is in danger of being infected so long as animals that have once been affected with pleuro-pneumonia are allowed to remain in it; and also that animals that have come in contact or been exposed to cattle that have once had an attack of pleuro-pneumonia endanger other herds which may come in contact with them.

In this connection I would also call your attention to sections 6 and 7 of "An act for the establishment of a Bureau of Animal Industry," &c., approved May 29, 1884, which makes it a misdemeanor to send animals affected with pleuro-pneumonia from one State into another. In view of the great danger now menancing the vast live-stock interests of our country on account of the presence of this dangerous disease in the West, this Department is determined to use all its influence to secure the prosecution and conviction of all parties who are responsible for the further dissemination of pleuro-pneumonia.

Hoping that you will destroy all animals in your herd that have been affected with this plague, and isolate the remainder of the herd that have been exposed to the contagion for three months after such exposure,

I am, very respectfully, &c.,

E. A. CARMAN,
Acting Commissioner.

Messrs. FRISBIE & LAKE,
Cynthiana, Ky.

On the same day the following letter was addressed to the Governor of Kentucky:

UNITED STATES DEPARTMENT OF AGRICULTURE,
Washington, D. C., September 13, 1884.

SIR: I deem it my duty to inform you that I have been informed by Dr. D. E. Salmon, Chief of the Bureau of Animal Industry, that Messrs. Frisbie & Lake, of Cynthiana, Ky., purchased twenty head of cattle of M. G. Clarke, of Geneva, Ill., at a time when contagious pleuro-pneumonia, or lung plague, existed in his (Clarke's) herd. Further, that Dr. Trumbower, an Inspector of this Bureau, recently examined the herd belonging to Messrs. Frisbie & Lake, and found some of the animals showing very marked symptoms of this disease, in the chronic form. Animals showing these symptoms are liable to infect others with which they may come in contact for an indefinite time after they have apparently recovered.

Shortly after the examination of this herd by Dr. Trumbower, a telegram was published to the effect that our Inspector found all the animals in a healthy condition. This was not true, as both Dr. Trumbower and Dr. Salmon affirm.

We have to-day addressed a letter to Messrs. Frisbie & Lake, requesting them to

suspend further sales of cattle for the present, and would be glad if you would do the same. Unless stringent measures are used this destructive plague will speedily extend over the entire country.

Very respectfully, &c.,

E. A. CARMAN,
Acting Commissioner.

Hon. J. PROCTOR KNOTT,
Frankfort, Ky.

The Department was informed by the secretary to Governor Knott that the contents of the foregoing letter were promptly communicated to Messrs. Frisbie & Lake.

The following letter, in reply to the one forwarded by the Department on September 13, was received from Messrs. Frisbie & Lake:

CYNTHIANA, KY., *September* 15, 1884.

SIR: We are in receipt of your communication without date, but, from postmark, mailed at Washington on the 13th instant, informing us that you have been informed by "Dr. D. E. Salmon, Chief of the Bureau of Animal Industry, that twenty head of cattle purchased by you [us] of M. G. Clarke, of Geneva, Ill., left that herd at a time when contagious pleuro-pneumonia existed in it." From card heretofore published by us, a printed copy of which is herewith inclosed, you will find a correct statement as to our purchase of Mr. Clarke, which will show the inaccuracy of Dr. Salmon's information as to our purchases. Mr. Clarke, from whom we bought, says it is not true that at the time our cattle left his herd contagious pleuro-pneumonia existed in it, or that it ever has. You further say in your letter: "I am also informed that some of these animals now in your herd, when recently examined by Dr. Trumbower, an Inspector of the Bureau of Animal Industry, showed very marked symptoms of this disease in its chronic form." By reference to our inclosed card you will see Dr. Trumbower's statement to us of the condition of our herd after he concluded his examination. That statement was prepared in Dr. Trumbower's presence, read to him, and after corrections made by him was said by him to contain nothing but the facts as he found them.

Dr. Trumbower, when he came to our place, was given every facility and our hearty co-operation. He began his examination on the 30th of August and concluded it on September 1. We demanded of him the result of his investigation, and he gave it to us as set forth in our card. From him nor other official of the Government did we receive any further information or communication of any kind regarding our herd. It may be imagined how painful was our surprise to read in the Commercial Gazette of Cincinnati of the 12th instant the following dispatch from its special correspondent:

"LEXINGTON, KY., *September* 11.

"A committee of prominent cattle-men went to Frankfort to-day to endeavor to procure quarantine orders against the herd of Jerseys at Cynthiana, Ky., the property of Frisbie & Lake. The United States veterinary surgeon examined the cattle and found a number of them infected with pleuro-pneumonia in its worst form. Armed with a report to this effect they went to Frankfort, but failed to make anything by it, no Kentucky law applying to the case. The cattle-men will probably have to take the law into their own hands unless the State provides for them. Fears that Ohio and other States will quarantine against Kentucky are expressed, which would seriously affect the market and cut off sale of a large amount of fat, salable cattle here."

Also the following special to the Louisville Courier-Journal:

"FRANKFORT, KY., *September* 11.

"Reliable and satisfactory information having been received by the cattle-breeders of this section of the State that veritable pleuro-pneumonia was now affecting the herd of Frisbie & Lake in the county of Harrison, a large delegation of breeders came to the city this evening to hold a consultation with the governor on the best means of preventing a spread of that dread disease. To give their cause of complaint its due importance, they showed the governor the following statistics: 'From 1711 to 1769 it destroyed 200,000,000 head of cattle in Europe; from 1793 to 1796, from 300,000 to 400,000 in Italy; and in 1842, 300,000 head in Egypt. In 1865 it had proved fatal to 500,000 head in Great Britain in eighteen months.' The same article says, 'the malady is propagated by contagion, that treatment is inefficacious, and that extinction of the poison by slaughter has been shown by the experience of a century and a half to be the only satisfactory and economical method of contending with it.' The attorney-general was present at the meeting, and said that the laws of Kentucky only provided for the impounding of diseased cattle, and could not cover the threatened danger. In the matter under advisement the breeders, among whom were Mr. A. J. Alexander, Mr. Lucas Broadhead, and others of this county—also of Scott, Fayette, and Bourbon Coun-

ties—then agreed to arrange for a meeting representing not only the large breeders, but all the cattle owners of the State, to devise ways and means of stamping out the disease and protecting their immense interests from its dread ravages. They ask the press of the State to please take notice of this intention on their part, affecting as it does the price and wholesomeness of beef, and consequently the interest of every individual in the State. A day and place of meeting will be designated later."

And also the following editorial:

"And so it seems, after all denials, that the fearful cattle scourge, pleuro-pneumonia, has broken out in at least one point in Kentucky—in a herd of Jerseys in the neighborhood of Cynthiana, Harrison County. Speedy measures should be adopted to stamp out the scourge, for otherwise it is impossible to form any idea of the ruin that awaits one of the largest and most important interests of the State. The peril of the situation is increased by the fact that Kentucky is without a law efficacious in the case. Already the leading breeders are moving in the matter, and no doubt something to the purpose will be accomplished."

And to find that articles of like tenor were in the Lexington papers. Thus, through the whole State, was disseminated the information upon authority of Dr. Trumbower that our herd was affected with the dread disease, pleuro-pneumonia, creating fear and consternation everywhere, and jeopardizing the values of all the cattle interests of the State. Immediately we telegraphed Dr. D. E. Salmon, inquiring of him what Dr. Trumbower had reported as to our herd, and thus learned for the first time from a Government official that it was reported our herd was infected with pleuro-pneumonia. We cannot conceive what changed Dr. Trumbower's views after leaving here as to our herd having the disease. We do not understand why, after his change of view, we were not notified of it, being the parties most deeply interested; why we were not notified by Dr. Salmon that he had so reported; why some official announcement of the fact was not made to us and the public, instead of seeking an indirect and, to us, unknown channel to reach the public through the press. We feel that we have been unfairly dealt with and may be wrongfully subjected to very great loss.

Thanking you for calling our attention to the law, we would say we have heretofore been law-respecting and abiding, and propose to continue so.

You will readily perceive from our statement as to Dr. Trumbower that we would be compelled to have more reliable evidence than any statement he could make to believe our herd was diseased. We do not believe that any of our herd is affected with pleuro-pneumonia; so believing, of course we will not destroy any of them.

Very respectfully, your obedient servants,

FRISBIE & LAKE.

Hon. E. A. CARMAN,
Acting Commissioner of Agriculture.

The following is the published card alluded to by Messrs. Frisbie & Lake in the foregoing letter:

NO CATTLE PLAGUE AT CYNTHIANA.

Editor Farmer's Home Journal:

A publication having appeared in the Breeder's Gazette and other papers that a certain lot of Jersey cattle had been shipped from M. G. Clarke, Geneva, Ill., to Cynthiana, Ky., we desire to say that about July 1 we purchased of Mr. Clarke seven registered Jerseys—three cows, one yearling, one last winter's, and two small calves; and about one month afterward received a letter from him stating that he would like to sell us another lot. The first purchase giving the satisfaction they did, we visited Mr. Clarke and made the second purchase of seven head, making in all fourteen head of registered Jerseys, Mr. Clarke putting in a grade heifer to pay freight from Geneva to Chicago, Ill. We received the first purchase with Nutrina of Tunlaw (9946), about the 1st of July, and the second about the 10th of August. Not having any intimation in the least that this stock had been exposed to any contagious disease, and they all being in fine condition, we, of course, turned them in with the balance of our herd, except the four calves, which were turned in a lot with a few other calves. We can state positively that not a single one of our entire herd of nearly eighty head has ever been sick since the Clarke stock was turned in with them, and we can now say, without fear of contradiction, that no herd of Jerseys in the world are healthier or freer from disease than ours. We had one calf that fell into the pond the day after arrival, and, we think, took cold, and has not done as well as the balance, but with this exception have had no sickness whatever, and can say to the world that our herd is entirely free from any contagious disease whatever, and stand prepared with our herd to substantiate this assertion.

Now for the investigation made by the United States Government on August 30 and September 1. Dr. M. R. Trumbower, United States Veterinary Inspector, was ordered to our place to inspect our herd by Dr. Salmon, Chief of the Bureau of Animal

Industry, and after making a thorough and careful examination of our entire herd, consisting of seventy-one head of thoroughbred cows and heifers, he found them all healthy and in good condition with the exception of one cow and one heifer that never saw the stock sold by Mr. Clarke to Mr. Keefer and Mr. Boyd, of Illinois. These two, he claims, have affection of the lungs, but would not pretend to state or say that they were affected with pleuro-pneumonia or any other contagious disease. These two, as well as the balance of the entire herd, are now in a fine, healthy condition. Then he carefully examined the calves running in the lot mentioned together. One of these calves he found with left lung consolidated, this being the calf that fell in the pond heretofore mentioned, and one other calf discharging at the nose and a cough, showing evidence of bronchial and lung affection in a slight form. The cough he attributed to eating rag-weed.

After examining and re-examining, this was the extent of his discovery of any disease in our entire herd. Nutrina of Tunlaw (9946), the cow that was said to have taken the disease to Mr. Clarke's place, and was supposed to have been badly diseased with the dreadful disease of pleuro-pneumonia of the worst form while at Mr. Clarke's, proved, upon three close and careful examinations by Dr. Trumbower, to be entirely free from any disease and sound as a bell, with the remark "that she was safe in any herd, and that we need have no fear of her." This cow has been running with our herd over two months. Now, if any breeder of Jersey cattle, with a herd of about eighty head, can say that after as thorough an examination as this he only finds two or three head out of condition he certainly is fortunate. Now, Jersey breeders and the public at large, you need have no fears of any disease from our herd. We propose to stand by them, knowing they will stand by us, for we know their healthy condition substantiates this statement.

In conclusion we desire to correct the statement made in the papers that there were twenty head shipped to Cynthiana, Ky., there being only the number named above. We wish to impress upon the public the fact that not a single head of our herd, including all the Clarke stock, both cows and calves, has ever refused for a single day to take its feed, and certainly this is of itself sufficient evidence of its healthy condition.

FRISBIE & LAKE.

CYNTHIANA, KY., *September* 1, 1884.

Three days later Messrs. Frisbie & Lake addressed the following letter to the Department:

CYNTHIANA, KY., *September* 18, 1884.

SIR: Since writing you on the 15th instant the following facts have occurred, which we deem it proper to advise you of. On Sunday last we observed an old cow of our herd was off and droopy, showing signs of sickness. There was nothing, however, in her appearance to excite alarm, nor were her symptoms those commonly attributable to cattle affected with pleuro-pneumonia. However, on yesterday the cow became very sick and much bloated. We relieved her by puncturing the stomach, allowing the gas to escape. But as she was evidently a very sick cow we immediately telegraphed to Dr. E. T. Haggard, veterinary surgeon at Lexington, to come here this morning. In response to our summons he came. The bloat of the animal prevented his making such examination of the lungs as would determine the extent of their affection, if affected at all, and he asked that the animal might be slaughtered and a *post-mortem* examination made. To this we readily consented, and the animal was killed and the examination made in our presence. The right lung was evidently very much diseased, and Dr. Haggard pronounced the disease with which the animal was affected as pleuro-pneumonia. Another animal in the same pasture is sick and seriously affected as the cow we slaughtered, and will probably die. Two or three cattle on another place are not well. Our herd consists of about two hundred and fifty head, and all of them had an opportunity to take the disease if contagious.

Very respectfully, your obedient servants,

FRISBIE & LAKE.

Hon. E. A. CARMAN,
Acting Commissioner of Agriculture.

The meeting of stock-men, alluded to by Messrs. Frisbie & Lake in their first letter to the Department, was held in Lexington, Ky., September 19, 1884. The Department is indebted to Mr. D. Runyon, secretary, for the following official copy of the proceedings:

PLEURO-PNEUMONIA IN KENTUCKY.

In response to an urgent request of the president of the Kentucky Shorthorn Breeders' Association, a large number of Jersey, Shorthorn, and grade cattle-breeders assembled at Lexington, Ky., September 19, 1884, to determine on the course of action

in regard to the report officially made that pleuro-pneumonia existed in the herd of Jerseys owned by Messrs. Frisbie & Lake. The Rev. Rutherford Douglass, a prominent Jersey breeder, was called to the chair, and Mr. Dan Runyon, of the Live Stock Record, was made secretary. Messrs. Frisbie & Lake did not arrive until the meeting had made some progress, but were represented by their attorney, Hon. Caleb West. Mr. Estill stated that the object of the meeting was to determine whether pleuro-pneumonia did or did not exist in this section, and that as it was a subject of vital import to cattle-men, we should at once take action on the affair. The chairman responded that the disease was the most destructive known, and that everything known of its existence in the State should be fully told. The secretary was then handed the following letter to read:

[This was the letter addressed by the Department to Governor Knott on September 13, 1884, quoted above.]

Several short speeches were then made by Attorney-General P. W. Hardin, Dr. Keller, Leslie Combs, Ethelbert Warfield, and others.

Mr. Henry Higgins said he would like to hear from the other side, and Judge West responded that all would be told in good time; that he would give everything that his clients knew, and stated that the first intimation they had of the existence of pleuro-pneumonia in their herd was a special dispatch sent to the Commercial Gazette. They expected to prove that Dr. Trumbower was unworthy of credence, as he made a statement in the presence of responsible parties to the contrary of the statement made therein.

Capt. Phil Kidd wanted to read a dispatch from a Nashville paper which charged pleuro-pneumonia on the cattle sold by Mr. Alexander McClintock at a recent sale. Mr. McClintock made a short but satisfactory speech, and when the proposition was broached offered to pay the expense of a committee going down to examine his herd, and part of the expense in killing any of the suspected cattle. This statement was received with much applause. Mr. McClintock, in response to a question, said that one of his cows was sick at Mr. Henry Higgins', and that gentleman referred to Dr. Haggard, who said he would delay his answer until later.

After further discussion the reports were traced through various sources to Dr. Trumbower, Government Inspector, who, on September 1, finished the inspection of Frisbie & Lake's Jersey herd at Cynthiana. Frisbie & Lake were ready to produce witnesses that Dr. Trumbower's conversation thereon during and immediately after the inspection induced them to believe that their herd was free from the disease, and that their card of denial was written in the presence of, read by, and corrected, in one instance, by Dr. Trumbower. On September 13 they saw a Lexington dispatch in the Cincinnati Commercial Gazette, giving Dr. Trumbower as authority, that four cases of pleuro-pneumonia existed in their herd. They telegraphed Dr. Salmon, Chief of the Bureau, who answered that such was the report. They then telegraphed for a copy of Trumbower's report, but never received a reply till September 15, when they received a communication from Mr. Carman, Acting Commissioner of Agriculture, mentioning a report from Dr. Salmon as explaining the introduction of the disease into their herd by twenty cattle bought from Clarke, of Geneva, Ill. But Salmon should know, and Trumbower had been told, that they only bought fifteen from Clarke, who denied the existence of the disease in his herd, and they could not understand why Trumbower should tell two different tales, or why they had received no official notification. They still refused to believe the disease was in their herds. They promptly answered Salmon's letter, also one from Governor Knott requesting them to make no sales from their herd. On Sunday they were notified that two ailing cows had been found. On Tuesday they had several cattle-men look at them, and were still without assurance of pleuro-pneumonia. Wednesday the cows grew worse, and they telegraphed Dr. Haggard, who arrived Thursday morning, held a *post-mortem* on one of the cows killed for the purpose, and found one lung completely diseased and the other touched by undoubted pleuro-pneumonia. He declared the other cow affected in the same way. They at once wrote the facts to all concerned, and stated them fully to the meeting. Dr. Haggard detailed the result of his examination, and showed pieces of the diseased lung. Another cow from Clarke's herd had the disease, and several others showed symptoms.

The following resolution wasoffered by W. P. Hardin, attorney-general, and unanimously passed:

"*Resolved*, That the statements of Messrs. Frisbie & Lake, with the accompanying papers and proof, we regard as satisfactory and conclusive of their honest, just, and gentlemanly conduct, both to themselves and the public, in regard to the presence of pleuro-pneumonia in their herds; and, appreciating their manly course, we thank them for the cordial and interesting information, as well as their expressed desire to fully co-operate with us."

The following resolution was offered by Mr. Leslie Combs, and passed unanimously:

"*Resolved*, That whereas a Government Inspector examined the herd of Frisbie &

Lake on August 31, and since he reported that pleuro-pneumonia existed in said herd, that this meeting condemns his concealment of the results, reported to the governor by Messrs. Frisbie & Lake, whereby they could not sooner have isolated their herd, and that a copy of said resolutions be forwarded to the Commissioner of Agriculture."

The following resolution, offered by Mr. W. W. Estill, was carried:

"*Resolved*, That it is the sense of this meeting that the governor at once call the legislature together to devise ways and means for exterminating plëuro-pneumonia as demonstrated by *post-mortem* to exist in our State."

The following resolution, offered by Mr. T. C. Anderson, was carried:

"*Resolved*, That the governor of Kentucky be requested to call upon the Commissioner of Agriculture of the United States to put into quarantine all the herds of cattle in this State suspected of being infected with pleuro-pneumonia."

Senator John S. Williams said the governor ought to be requested to call the legislature into extra session to consider the matter, and if such session is not called the cattle should be at once slaughtered, and he felt sure that the next legislature would pay the owners a reasonable price for them. He said that if something is not done to stamp out the disease it will destroy the cattle interests of the State.

The following resolution was offered and adopted:

"*Resolved*, That Messrs. Frisbie & Lake and the Chair appoint a committee to devise ways and means to exterminate the disease."

The Chair appointed the following committee in conformity with this resolution, viz: General P. W. Hardin, A. J. Alexander, Leslie Combs, William Warfield, and D. A. Givens.

The meeting adjourned to meet again in Lexington on Saturday, September 27, 1884.

R. DOUGLASS, *President.*

D. RUNYON, *Secretary.*

September 24 I visited and inspected this herd. I examined particularly the animals Dr. Trumbower reported to be diseased, and was able to confirm his report in every respect. At that time a number of additional animals were suffering from pleuro-pneumonia, and several seemed to be in the first stages of this disease, but owing to the great number in this herd, and the large pastures in which they were running, I was unable to make a careful examination of all the animals.

October 3, Dr. Paaren, State veterinarian of Illinois, found a Jersey heifer at Saint Charles, Ill., which belonged to W. A. Stewart, and had been purchased from Mr. Clarke, that was suffering from pleuro-pneumonia; also a ten-year-old native cow, belonging to the same gentleman, which had been running with this heifer and had contracted the disease from her. Both were slaughtered, and a *post-mortem* examination is said to have revealed typical pleuro-pneumonia. The following week Dr. Paaren killed a second Jersey heifer at Saint Charles, which belonged to D. B. Moore, which had been purchased early in the spring from the Clarke herd at Geneva.

The following is a recapitulation of the total number of animals affected in this outbreak according to our information:

Owner.	Number exposed.	Number affected.
C. R. C. Dye	65	20
C. N. Mitchell	30	13
W. C. Clarke*	34	17
John Boyd	21	13
D. H. & S. S. Tripp	65	7
O. J. Bailey	60	5
A. G. Epler†	100	8
D. W. Rawlings	1	1
W. A. Stewart	....	1
Frisbie & Lake	250	16
Total	626	101

* Includes the animals sold which were afterwards found diseased.

† About the number exposed previous to the sale, and the number affected includes those which contracted the disease after the sale.

The following statement was prepared for the use of the House Committee on Agriculture in January, 1884:

EXTENT OF PLEURO-PNEUMONIA AND THE IMPORTANCE OF NATIONAL ACTION IN REGARD TO THE CONTAGIOUS DISEASES OF ANIMALS.

The extent of territory infected with contagious pleuro-pneumonia of cattle and the number of animals actually suffering from this disease, are insignificant in comparison with the annual direct and indirect losses traceable to it, and the danger to which our immense live-stock industry is continually subjected.

In Connecticut two herds were infected during the past summer, in which 12 animals were exposed and 7 contracted the disease. In one of these herds the affected animal was destroyed, and at last accounts no others had contracted the disease; in the other herd 4 animals had died, or had been killed, and 2 with very extensively diseased lungs remained in quarantine. Both of these were Jerseys, and the owner refused to have them destroyed. What has been done with them, or what will be, I am unable to say, as the State authorities seem powerless to proceed beyond quarantine, and this seems to have been by no means secure.

In the State of New York, although the disease is almost entirely confined to the western end of Long Island, to Staten Island, and New York City, these localities are quite extensively infected, and as there are more than two thousand stables, some of which contain several hundred cows, and many of which contain from 50 to 100, it is the most dangerous district in the country at this time. Recent reports are to the effect that the disease is extending through the river counties, and exists in herds located from 50 to 60 miles north of New York City. How many cattle are affected in these counties I am unable to say, but the existence of the disease here is really of much greater importance to the country at large than the number of diseased animals would lead one to suppose, because it is a district where many thoroughbred cattle are raised and from which they are shipped to all parts of the United States.

New Jersey was recently supposed to be nearly free from pleuro-pneumonia, but the fact that a number of cases occurred without the knowledge of the State authorities, that a still larger number of herds were lately known to be infected in Union and Essex Counties, and that a very extensive outbreak in Hunterdon County was recently traced by means of sick cattle shipped to the New York market, and discovered by the inspector employed by the United States Department of Agriculture who is stationed at Jersey City, leads to the suspicion that a thorough inspection of the State might bring to light still other cases. The Hunterdon County outbreak was one of the most extensive that has recently occurred. It was supposed to have originated from a car-load of cows brought from Pennsylvania; but where these were infected is not known. Seven herds, at last accounts, were in quarantine; and as all were large herds, containing from 40 to 70 cattle, a large number of animals were exposed.

Inoculation was extensively practiced to check the fatality; but, in spite of this, reliable authority places the loss at over 50 head.

In Pennsylvania there has recently been another very extensive outbreak, which was the result of taking a car-load of 14 cows from the Calvert stock-yards in Baltimore to Chester County. Most of these cows were taken into large dairy herds, which they thoroughly infected. In each of these cases the Baltimore cows were the first to sicken, and a large proportion of the native cattle were soon affected with the same disease. These herds were visited the 3d of October by the Veterinarian of the Department of Agriculture, in company with the State authorities, who killed 8 of the animals in his presence in order to satisfy him as to the nature of the disease. The cases were typical cases of pleuro-pneumonia, and all those appearances were present which were recently accepted by the International Veterinary Congress held at Brussels as characteristic of contagious pleuro-pneumonia. In most cases a whole lung was hepatized; the inflammation was of different ages, showing the progressive character of the disease; the interlobular tissue was greatly distended with the exudation, and the pleurisy was intense. According to an official report, dated October 30, the number of animals known to have been exposed was 104, and the number of sick ones that had been killed or had died was 46. A semi-official report of the present month places the number destroyed at 70. It is now believed that the disease has been entirely overcome, and that the State of Pennsylvania is free from it.

In Maryland and the District of Columbia there are many infected herds in which a comparatively large number of animals annually contract the disease. By direction of the Commissioner of Agriculture a reliable Inspector was sent to Baltimore late in October to learn the condition of the stables there as regards this disease.

Nineteen stables, containing 398 animals, were examined. In twelve of these the infection was admitted; one had lost more than 200 animals within three years; others had lost heavily for years; 12 sick animals were found, 18 recent deaths were

admitted, and 3 sick cows had just been sold or exchanged. This number of stables comprises but a small part of those in the vicinity of Baltimore, but it is believed that the number is sufficient to demonstrate the presence and dangerous character of the disease. We have no information of pleuro-pneumonia in the country districts of Maryland at any great distance from the cities.

One or more herds near the District of Columbia have recently lost a number of cows, and at latest accounts had some sick. Within the District, without making any regular inspection, three infected herds have been found where from 3 to 6 animals are admitted to have been lost within the year. In Virginia there are stables from which animals have recently been lost with symptoms of this disease; but none of these could be secured for examination, and therefore we can not be positive in regard to the nature of the disease.

REASONS FOR BELIEVING IT CONTAGIOUS.

The first great reason for believing this to be contagious pleuro-pneumonia is the fact that nowhere in the country outside of the comparatively small strip of territory stretching from Connecticut to Virginia, and east of the Alleghany Mountains, have any cases been found which bear any close resemblance to the disease under consideration. If this disease were the result of climatic causes, or if it were produced by improper food and care, then we should certainly find it distributed over the whole country, or at least in all of those parts of it where similar conditions exist. It cannot be originated by the manner of stabling and feeding cows near our Eastern cities, for substantially the same conditions exist at Rochester, Buffalo, Cleveland, Detroit, Chicago, Saint Louis, Cincinnati, and other Western cities, and no veterinarian has been able to find any similar cases of disease there, although special inspection has been made by competent persons.

The disease is not confined to stable cows, however, nor to those seasons of the year when acute lung diseases can be accounted for by the inclemency of the weather. The outbreak referred to in Connecticut occurred in the summer, in a country district, and where the cattle were running upon nice pasture fields. The extensive outbreaks in New Jersey and Pennsylvania also happened in summer, and were in the best farming districts of these States.

In this connection attention is called to the fact that in the State of Pennsylvania about ninety herds have been infected since March, 1879, and that notwithstanding the appointment of special agents in every part of the State, and the investigation of all cattle diseases wherever found, there was no disease resembling pleuro-pneumonia discovered except in eight of the sixty-seven counties of that State. The remaining fifty-nine counties have been free from any suspicion of this plague. What is even more significant is the fact that these counties are not distributed over various parts of the State, but that they join each other, and are all in the southeastern corner of the State, where there is the greatest danger of infection by cattle brought from Philadelphia and Baltimore. With seventeen of these herds the infection was traced to cattle from Baltimore or other points in Maryland; with twenty-one it was traced to Philadelphia; with ten it was traced to cattle from herds in Pennsylvania known to be diseased.

The most favorable conditions of life were not sufficient to protect the cattle where this disease was introduced. I have already mentioned that a number of the outbreaks referred to occurred during the summer, and that the animals were running upon irreproachable pasture fields. Many of the affected cows were young and in fine condition. In Connecticut a Jersey bull, less than two years old, and two steers fit for beef, were among the victims. Again, the disease as we see it here does not occur in isolated herds a single case at a time, as does non-infectious lung disease, but when it enters a herd a majority of the cattle are affected sooner or later. Some of the herds in Brooklyn and Baltimore have been losing cows from this plague for years, and one near the latter city, where but about fifty cows were kept at a time, has lost between 200 and 300 cows within three years.

These instances, all recent, are referred to, not as all the evidence bearing on this point, but simply as examples of what has been occurring for years past; and it is believed that they cannot be explained on any other hypothesis than the contagiousness of the disease.

DANGER GREATER THAN EXTENT OF INFECTED TERRITORY AND NUMBER OF DISEASED ANIMALS WOULD INDICATE.

Glancing over the territory which I have stated to be infected, it must be confessed that it is not extensive—a single farm with perhaps five animals in Connecticut, about four counties in New York, as many in New Jersey, two or three counties in Maryland, and possibly a few stables in Delaware and Virginia.

In most of the infected herds there are but one or two sick animals at a time, and frequently there are none; for where the disease has existed for a certain time the susceptible animals die off and only those which possess a certain immunity from it remain.

As about 20 per cent. of all the animals exposed are able to resist the contagion indefinitely, a herd of comparatively insusceptible cattle is in time acquired, and the time necessary for this is shortened both in Baltimore and Brooklyn by the practice of inoculation.

But these stables and grounds remain infected, and a large portion of the new cows brought into them contract the disease unless they are previously protected by inoculation. The practice of inoculation does not destroy the infection; on the other hand it keeps it up, but it enables dairymen to keep their cows in infected stables without great loss, when without it more than half of the new cows brought into them would surely die.

Another fact of great importance brought out by the experiments of the French pleuro-pneumonia commission is that about 30 per cent. of the animals exposed to this disease show no symptoms of it beyond a slight cough. Such animals are probably as dangerous to others as those which have it in a more severe form, and yet they can be transported to various parts of the country without exciting the least suspicion.

The animal which is supposed to have caused the outbreak in Connecticut was probably in this condition, as a careful examination of her lungs did not enable the veterinarians to detect any evidences of the disease; and yet pleuro-pneumonia existed in the stable from which she came, and her admission into the new herd was followed by the seven cases that have been mentioned. Similar instances are referred to again and again by the veterinarians of every country where the disease exists.

These infected districts, though small, are then a real danger to the whole country, because all the way from Connecticut to Virginia there is a large and increasing number of herds of thoroughbred cattle, which are frequently shipped to the West and some of which have from time to time been infected with this disease. Fortunately, the owners of thoroughbred cattle have generally had too much regard for their reputation to ship cattle when there was any disease in their herds, and the common cattle have not been sent to a sufficient distance to do much harm.

But with the increased price of cattle a large number are being shipped from the East toward the West, and the danger of carrying the disease is consequently increasing. If the car-load of cattle shipped from Baltimore to Chester County, Pennsylvania, had gone to the ranges of the West, they might have done irreparable harm. Again, the thoroughbred Jersey cow which went from an infected stable in New Jersey might as readily have been shipped to the West; and I have been informed that if the Connecticut outbreak had occurred a few months later one or more of the herds would have been sent, according to contract, to a Western State. Now, while it is true that pleuro-pneumonia has existed in the East for forty years without having been carried to the West, it must be admitted, from what has occurred so many times in Pennsylvania and Connecticut, that there has been danger of this, and that this danger is increasing with the larger number of cattle now being shipped in that direction. No doubt this danger has been exaggerated, but the fact that there is danger, and that the disease once carried to the Western herding grounds would probably be beyond our control, if we can judge from the experience of Australia and South Africa, is sufficient to show the importance of grappling with it while it can be so easily handled. The rapidity with which a disease spreads on these ranges, when once introduced, is illustrated by an occurrence of last summer in Southwestern Texas. A drove of cattle brought a communicable disease to that section, which the army surgeons believed to be contagious pleuro-pneumonia; but before any careful examination could be made several hundred cattle had died, and a large territory was infected. Fortunately, investigation showed that this was not pleuro-pneumonia, but a disease which does not outlast a single season of the year. If it had proved to be pleuro-pneumonia, would it not have been a national calamity? With a large territory already infected, with no money and no power to control the disease, and occurring in summer months, before the State and national legislative bodies would convene, it is difficult to see how any effective measure could have been adopted.

THE INEFFICIENCY OF STATE ACTION.

Though a number of attempts have been made by the States now infected to rid themselves of pleuro-pneumonia these have generally or always failed, because for various reasons the work was not thoroughly done. We saw the State authorities of Connecticut unable to exterminate the disease a few months ago, when but a single herd contained sick animals. The stables of Brooklyn were never under complete supervision, and some could not be entered by the inspectors even when the State of New York was most active in its endeavors at extirpation; and though the authorities of New Jersey have been engaged at the same task for five years, the State

has probably never during that time been entirely free from pleuro-pneumonia. In Maryland the assertion has been made again and again that there were no cases of this disease in the State, and yet during any part of this time a thorough inspection could not have failed to reveal a considerable number. At best the attempts of the States have been spasmodic; and while one State was earnestly striving to accomplish something a neighboring one would allow the shipment of diseased cattle, and counteract the influence of the former. As a rule, therefore, State action has never been thorough, and the lack of unity of action between the States has prevented any lasting benefit even when much has been accomplished.

ADVANTAGES OF THE WORK BEING DIRECTED BY THE UNITED STATES GOVERNMENT.

A national direction of the work for the extermination of pleuro-pneumonia would overcome at once the discouraging features which have done so much to prevent the efforts of the individual States from being effective. With inspections in every infected State the shipment of diseased cattle would soon cease; new outbreaks would thus be prevented, and the danger which has so long menaced the great cattle interests of the country would be removed. The work would be more thorough and energetic, because those engaged in it would not be directly or indirectly dependent upon the good-will of the interested cattle owners for their positions, and the plea of inability to pay for the diseased cattle which ought to be slaughtered would also be overcome. These have been the principal obstacles to the success of State action, and practically they are so great as to make it next to impossible for the States alone to free themselves from this plague.

THE PRESENCE OF PLEURO-PNEUMONIA COSTS ANNUALLY MORE THAN WOULD BE NECESSARY FOR ITS DESTRUCTION.

Owing to the presence of pleuro-pneumonia in the United States, every steer shipped to Great Britain must be slaughtered within a certain time on the wharf where he is landed. This restriction upon the export cattle trade is said by competent authorities to make the price of our steers average $10 less than similar animals shipped from Canada. With over 100,000 beeves going abroad every year, this makes a loss of $1,000,000 annually, or enough to clear our country of the disease. Besides this, there are the continual losses which are going on in the infected districts, and the disturbed condition of trade from the many false alarms in regard to the spread of this disease, the entire annual losses being estimated by good authorities as high as $3,000,000.

IMPORTANCE OF INVESTIGATING OTHER DISEASES.

The proposition of establishing a permanent bureau for investigating the communicable diseases of animals is a matter of the greatest importance. While we have no more disease than other countries in proportion to the number of our animals, the enormous development of our live-stock industry has made the question of contagious diseases one of peculiar interest to us. The cause of these plagues, which has been an impenetrable mystery during all the past ages of the world, is being revealed by the science of to-day, and the infinitely small organisms which are able to produce such terrible havoc in our flocks and herds are at last being brought under subjection themselves, and their study has revealed much of the greatest value to us in our warfare against them. A country with so much at stake, with millions of dollars annually swept away by this class of maladies, cannot afford to be idle. Other nations which have much less capital invested in animals than we have, see the necessity for this work and are making provisions for it: and it is to the credit of our country that we were one of the first to enter this field, and that results have been accomplished which will bear comparison with the investigations of any other country. But while much has been done, while millions of dollars have already been saved to our farmers by the facts thus far discovered, we have only made a beginning in the great work that is before us. Some of the most important diseases affecting our animals are still mysteries to us, and though they are distributed over large territories and decimate the live stock, we are ignorant of their cause; we do not know how they are kept up from year to year; we have no means of combating them, and the idea of freeing ourselves from their ravages has scarcely dawned upon us. A striking example of the necessity of such work is seen in the recent investigations of Texas cattle fever. This disease has been advancing and infecting new territory for a century, and until the last year or two we knew nothing about it, and our best informed veterinarians and stockmen did not suppose that it was found in one-fifth of the territory which it has actually overrun. These were points which it was necessary to understand before either legislative bodies or individuals could adopt intelligent measures for preventing the annual losses which have been most discouraging to the cattle

industry in large sections of the country. And with every disease there are equally important points still to be investigated.

The laboratory and experiment station which have been fitted up during the past summer under the direction of the Commissioner of Agriculture, for investigating contagious diseases, make it possible to attempt the solution of questions which were formerly beyond our reach. The laboratory contains the most improved apparatus for such investigations, much of which was constructed according to new designs, especially for this work, and it is safe to say that the facilities here are now equal to those possessed by investigators of similar diseases in any country, and in some respects they greatly surpass them.

In conclusion, I would say there is not a department of original research or of agricultural investigation in regard to which there is more pressing need for development than this, and none which promises to effect a greater saving. Our losses are now heavy, but they must increase as our animal population increases, as new diseases are introduced, and fresh areas are infected. But it is not alone a question of dollars; the investigation of animal contagia must throw new light on those human plagues which in our country alone sweep a quarter of a million of human lives out of existence each year. Some of these animal diseases are communicable to man, and have a greater influence over our health and lives than is generally supposed, and any means of controlling them cannot fail to have an important influence on human health as well.

ENZOOTICS OF ERGOTISM.

Early in March, 1884, a disease among the cattle of Coffey County, Kansas, which was supposed by certain veterinarians to be foot-and-mouth disease in a most virulent form, was brought to the attention of the officers of that State; and such exaggerated accounts were sent to the press from day to day as to cause a feeling of insecurity and alarm among all engaged in the live-stock industry of the West. The 3d of March, Dr. Wilhite visited the farm of Mr. Daniel Keith, located in Coffey County, 4 miles northwest of Neosho Falls, and pronounced the trouble among his cattle to be foot-and-mouth disease. The same day Governor Glick telegraphed as follows:

TOPEKA, KANS., *March* 3, 1884.

HON. GEO. B. LORING,
Commissioner of Agriculture:

A very malignant disease has broken out among the cattle in Neosho County, this State. It is supposed to be the foot-and-mouth disease. The feet become sore and soon rot off. The disease sometimes extends to the knees. Over a hundred animals have been attacked in a few days. Great consternation among the cattle owners. Can your Department send here a competent veterinary surgeon? No one here can advise what to do.

G. W. GLICK, *Governor of Kansas.*

Two days later the following dispatch was received:

TOPEKA, KANS., *March* 5, 1884.

HON. GEO. B. LORING,
Commissioner of Agriculture:

[illegible]terinary surgeon reports disease of which I advised you to be foot-and-mouth disease.

G. W. GLICK, *Governor of Kansas.*

[illegible] dispatch, and similar representations by the senators from Kansas, Dr. W. R. Trumbower, a veterinarian whose previous reports of various diseases had led us to put great confidence in his knowledge and judgment, was directed to proceed at once to Neosho Falls, and make an early report in regard to the nature of the disease among cattle which was said to exist at that place. He started on the [illegible]th, but could not reach the affected farms until the 9th of March.

[illegible] the mean time, at the request of the governor, General Augur de[illegible] Holcombe, of the army veterinary service, to make an im-

mediate investigation. In company with the governor, the secretary of the State Board of Agriculture, and a delegation of citizens from Emporia, Dr. Holcombe reached Neosho Falls March 6, and after a hurried examination of the Keith, Goodrich, and Beard herds he reported that the disease was the genuine epizoötic aphtha of Europe. The following dispatch was received at the Department of Agriculture the same day:

NEOSHO FALLS, KANS., *March* 6.

HON. GEO. B. LORING,
Commissioner of Agriculture:

Veterinary surgeons A. A. Holcomb and A. H. Wilhite have to-day made an examination of the infected cattle, and pronounce it foot-and-mouth disease. Over 100 head are affected, but the disease is confined to stock cattle on a half dozen farms.

G. W. GLICK, *Governor of Kansas.*

When Dr. Trumbower reached Neosho Falls, he found an excited throng of people who urged upon him the necessity of making an immediate diagnosis, and relying rather upon the representations of others, which in many important respects proved to be incorrect, than upon what he was actually able to see, and a careful judgment based upon this alone, he was led to concur in the opinion of the professional gentlemen who had been upon the ground for the preceding three or four days.

On March 10, Dr. Holcombe made his formal report to the governor, in which occurred the following sentence:

That it is foot-and-mouth disease cannot be doubted when the symptoms are considered; for to recapitulate, the various cases show vesicles and ulcers of the mouth; vesicles and ulcers in the cleft of the hoof; suppuration and sloughing at the foot; ulcers of the rectum; vesicles and ulcers of the udder; diarrhea; a temperature varying from 101 to 104.4 degrees Fahr., and the most remarkable emaciation even in cases where the appetite is good.

The excitement now became so great that by your direction I left Washington, March 13, to investigate the nature of the disease and to see what action, if any, was necessary to hold it in check. At Chicago I learned of what was supposed to be a similar outbreak at Effingham, Ill., and was requested by Dr. Rauch, secretary of the State Board of Health, and by others largely interested in the cattle industries of the State, to make an immediate investigation. The condition of affairs in Kansas, however, was so urgent that I concluded to press on as rapidly as possible.

I reached Topeka March 15, and immediately had an interview with the governor and with the secretary of the State Board of Agriculture. I was informed by both that the malady was undoubtedly foot-and-mouth disease, but that it was so quarantined that there was little danger of its immediate extension; and at the request of the governor I proceeded the following day to Pawnee County, to investigate a supposed outbreak of pleuro-pneumonia. I found the cattle there to be suffering from chronic indigestion, the result of feeding too exclusively for a long time on dried sorghum with a probably insufficient water supply.

I at once returned, reaching Neosho Falls March 19, and after a careful investigation was able to telegraph you on the 21st that the affection was not foot-and-mouth disease, but that it had been produced by local causes and that there was no danger of its spreading.

Returning through Topeka, I reported my conclusion to the governor and was informed that experiments would be made with susceptible animals to decide the nature of the disease. I was invited to assist in these experiments, and at first decided to do so, but I soon learned that

the investigation necessary to satisfy Dr. Holcombe, who had just been appointed State veterinarian, was such as to require much more time than I could give to it. I accordingly visited Kirksville, Mo., by your direction, where I found an outbreak of the same disease as existed at Neosho Falls, and from there returned to Washington.

In Kansas I met Professor Stalker, of Iowa, Professor Faville, of Colorado, Colonel Groom, of Texas, and Dr. Hopkins, of Wyoming, who had been commissioned by their respective States to report on the nature of the disease and the necessity of quarantining all cattle, sheep, and pigs from Kansas. I was also requested by the secretary of the Illinois State board of health to inform him if there was any necessity for his State to adopt similar measures. Fortunately, each of these States received a report that foot-and-mouth disease did not exist in Kansas, and what threatened to be an almost complete suspension of the live-stock business of the West was averted. There is no doubt, however, that the cattle industry suffered a considerable loss from the excitement. The market became unsteady, the price of cattle declined, and buyers became exceedingly cautious.

April 9 I received information that Dr. McEachran, principal of the Montreal veterinary school and live-stock inspector for Canada, had visited Neosho Falls, Kans., and Effingham, Ill., as the representative of the Canadian Government, and positively asserted that the malady at both places was the real foot-and-mouth disease of Europe. April 10, a telegram from the State agent for Kansas of the United States Department of Agriculture conveyed the information that the State veterinarian had just reprted to the governor that six healthy cattle cohabited with the sick animals had all contracted the disease, and that further experiments by inoculation would at once be made. A letter from the governor of the same date, received two days later, contained similar statements. A few days later still an item appeared in the press dispatches from Washington, stating that "a private dispatch was received here to day from the governor of Kansas, saying that cases of sickness among cattle which had been most carefully examined had turned out to be true foot-and-mouth disease. He was afraid that some cases had got in the herds. There was an attempt made at first to keep the matter quiet, but the information was deemed such as should go to the public."

It now seemed that a repetition of the former excitement and panic was about to occur, and by your direction I visited Kansas a second time with instructions to make such experiments as might be necessary to demonstrate the non-contagious nature of the disease beyond question. I reached Emporia April 20, and was there met by a telegram from Neosho Falls asking me to join the State veterinarian and Professor Law at the governor's office on the morning of the 22d. Not intending to turn backward until the difference of opinion was conclusively settled, I telegraphed in reply requesting these gentlemen to meet me at Emporia on their way to Topeka. This they did on March 21, and I had a conference with them, at which the State veterinarian admitted that all attempts to convey the disease by inoculation upon cattle, rabbits, and sheep had failed; that the second experimental lot of cattle which had cohabited with the first lot when they were supposed to be suffering with foot-and-mouth disease had not been in the least affected; that the foot symptoms of the first lot had only been noticed with two animals, were very slight and of exceedingly short duration; and that, finally, whatever the disease might be, it was not the continental foot-and-mouth disease.

After receiving this information I returned to Topeka, attended the meeting of the live-stock commission in the governor's office, when the State verterinarian reported that the malady at Neosho Falls was not the foot-and-mouth disease, and the governor sent out a dispatch to the same effect.

On my way to Washington I visited the herds in the vicinity of Effingham, Ill., examined the cattle and the food and assured myself that the disease there was identical with that in Kansas and Missouri, and that it was in every case traceable to the ergot which existed in great abundance in the hay.

SITUATION OF THE AFFECTED HERDS AND BRIEF HISTORY OF THE DISEASE.

The cattle disease in Kansas which recently attracted so much attention from its supposed identity with the contagious foot-and-mouth disease of Europe, was first noticed in the herd of Daniel Keith about the 23d or 24th of December, 1883. Mr. Keith's farm is located 4 miles northwest of Neosho Falls. The first to sicken were some yearlings, which were noticed in the morning standing "humped up," with drooping heads and jerking the hind feet in a peculiar manner. These would walk but little and would soon lie down. Within two or three days they were inclined to lie continually. The feet were examined and found free from mud; the interdigital space was described as red, swollen, and sensitive, the toes spread apart. The feet began to swell at the coronet, or as high as the fetlock; a line of separation was established, and pus appeared within two or three days from the first symptoms. The mouths were not examined, but the animals were supposed to be eating all right.

On or about December 10, Mr. Keith had purchased 63 head of yearlings of Mr. Davis, all of which had been gathered within a radius of 10 miles. Two cows and 6 yearlings were bought of Alexander Linn, 1 mile down the river from Neosho Falls. This lot of yearlings were said to have sickened within a few days after their arrival on the Keith farm; it is believed that some were sick within three days and that all were suffering within a week, and during this time they had been fed on shelled corn and mowed oats. There appears to be some doubt as to how severely they were affected, whether they were all attacked on the same day, and the exact number of days they were on the farm before showing any symptoms. While it was asserted that they ate no hay it was admitted that there was probably some hay in the racks. Eight other animals were purchased about the same time of neighbors living within 2 or 3 miles.

By January 1 he had between 20 and 30 head sick, a number of new cases being observed each day. March 9 Dr. Trumbower found a red yearling steer with a very hot mouth, mucous membranes much reddened, a vesicle the size of a dime on the soft palate, and two smaller ones on the tongue. There was also a small ulcer on the mucous membrane of the rectum; the temperature was 104.4° F.; the animal was lying down, and when forced to rise it moved very stiffly, but there was no swelling of the feet. The following day the vesicles were found ruptured, and in their place was a deep, red cavity which bled when touched. Temperature still 104.4°. March 20 this animal appeared well.

The cattle on this farm were divided into two lots, which were in adjoining inclosures, and were separated only by rail fences. The second lot contained 40 two-year-old steers, purchased about November 1, and

was free from disease until February 28, though some of these had broken through the fence at times and mingled with the diseased part of the herd. March 10 about 10 or 12 animals in the second lot were sick. Three days later Dr. Trumbower found 2 that would lose all four feet. At this time there were 118 head of cattle on the farm, of which 74 were more or less affected. Nine animals had one foot off, 4 had two feet off, 1 four-year-old cow lost both hind feet and a toe from one fore foot, 3 others were affected in but one foot, 6 in two feet, and 1 in three feet. In nearly all that showed lameness there were more or less mouth symptoms.

Across the road, and nearly opposite to Mr. Keith, lives Edward Hindman. It was here that the cattle belonging to A. C. Goodrich were located. The 10th of March this herd numbered 96 head. The first animal affected was a milch cow, noticed to be lame January 10. No other cases occurred until February 14 or 15, when one was seen to be lame in the morning after a heavy ice storm. The following morning 16 were lame. After that he discovered new cases almost daily, and on March 14, when they were separated from the well ones, 65 head were affected. March 19 the most severe cases were as follows: 18 animals had lost both hind feet, 5 had lost one hind foot, 1 had lost both hind feet and one fore foot, and 1 had lost all of its feet. Seven of the others were lame in the hind feet, and the remainder of the 65 head affected were more or less lame.

In each of the above-mentioned herds the sick animals at the time of my visits, March 19 and 22, had small erosions of the mucous membrane of the mouth, and 2 or 3 had hard yellowish crusts in the same situation an inch or more in extent. In no case were these sufficient to interfere with mastication. This lesion was more noticeable in the old chronic cases than in the recent ones.

The third herd which contained diseased animals was located about 2½ miles from those already mentioned. It belonged to J. W. Beard. This herd contained 70 head of animals, and 3 cows and 2 steers are all that have been affected. All had been running together until the disease was noticed, when the sick were separated from the well. The first symptoms were observed on the 17th of February, when a cow was seen to be lame. The second one to go lame was a cow bought of Mr. Keith and brought to the farm February 18—she became lame about the 22d or 29th, accounts differing between these dates. The third one, a steer, became affected March 1. The fourth was a cow observed to be sick March 1 or 2. It is reported that she slavered very profusely. Mr. Beard states that he examined her mouth and found it very red and the tongue covered with little pimples. At ten o'clock next morning she died. This animal had not been lame. The fifth one was taken about the same time. It was lame in one foot, became better, was affected in a second foot, and was entirely recovered from lameness by March 11. At this time Dr. Trumbower found several small sores and discolored spots in the mouth, and the temperature was 102.5 degrees, or very nearly the average of cattle in health. The highest temperature found by Dr. Trumbower was that of the cow purchased of Mr. Keith, which reached 102.8 degrees—a point too low to indicate fever with any certainty.

The fourth and only remaining herd in the neighborhood of Neosho Falls was that of Christian Pribbernow, whose farm is located on Owl Creek, 10 miles southeast of the town. There were on this farm 183 head of cattle, and but 16 have shown any signs of the disease. This herd was made up as follows: 54 yearlings, 24 two-year-old steers, 13

two-year-old heifers with calf, 15 three-year-old steers, and 77 cows and heifers. The yearlings had been put in a separate pen and fed on oats and corn-fodder—none of these were affected. Three apparently well animals were lassoed and examined; their mouths contained small erosions and discolorations of the mucous membranes. The temperature of one, thought to be slightly lame, was 101 degrees; that of another, apparently in perfect health, was 103 degrees. Six of the affected ones have either lost their feet or have them in such condition that they will surely separate from the legs, and 2 others have lost digital bones. None of these animals have shown salivation or loss of appetite; but the mouths contained erosions and discolorations similar to those seen in other herds.

At Hall's Summit, a distance of 20 or 25 miles north from Neosho Falls, George R. Smith owned 2 cows. About February 1 one became lame; there was noticeable slavering and loss of appetite for several days. This cow calved February 29, and Dr. Trumbower saw her March 17, when the calf appeared well but small. The cow was reduced to a skeleton. Her right hind leg had broken off half way between the fetlock and hock joints, carrying with it the lower half of the metatarsal bone. The left hind leg was separating at about the same point. One toe of the left fore foot was coming off at the first joint.

Near Hartford, some 20 miles northwest of Neosho Falls and 15 miles west of Hall's Summit, was the farm of Mr. O'Toole, where another outbreak of disease occurred, showing precisely the same symptoms. The animals at this place were reported to have been killed before my visit, and consequently I did not see the herd. Dr. Wilhite, as I was informed, thought the first cases appeared about January 10. The first animals attacked were yearlings. Soon after all the calves became affected in the same way. Then the large steers in the feeding pen were attacked.

About the middle of March the governor of Kansas sent a veterinarian to investigate a disease which was reported to exist in Osborne County. According to verbal information which I received from the State officers while at Topeka, this disease was substantially the same as that which existed at Neosho Falls. The distance between these two points must be at least 175 miles in a direct line.

After investigating the disease in the neighborhood of Neosho Falls, I proceeded as directed to Kirksville, Adair County, Missouri, to visit herds at that place reported to be affected with foot-and-mouth disease. On March 27 I was at the farm of William Bragg, who lived 5 miles south of Kirksville. The disease in this section was first noticed here, but later 6 other herds, within a radius of 4 miles, have had affected animals. The only new animal introduced on the Bragg farm was a steer bought in the neighborhood about December 20. This was one of the first to sicken, but there was no disease on the farm from which it came. A cow that had been purchased a month earlier sickened about the same time. This was in the latter part of January. The weather had been extremely cold early in January, and reached 10° or 12° below zero at other times during the month.

At the time of my first visit there were 4 animals lying in the stable. One cow had lost a hind leg from about half way between the hock and fetlock joints; the bones had separated at the latter joint and the metatarsal bone protruded half its length beyond the flesh. The other hind leg was dividing at the fetlock joint. Six inches at the end of the tail was gangrenous, and was being separated from the remainder of the organ. There were a number of abrasions and small discolored spots in

the mouth. A second cow had a healthy mouth; both hind feet were lost at the coronet, and the tip of the tail was gangrenous. A steer, probably two years old, had lost both hind feet at the fetlock, about an inch of the tail was lifeless, and the mouth contained a number of sores and discolorations. A second steer was in almost precisely the same condition. A third steer was walking around the yard, very lame, and had a large slough of the tissues on the posterior surface of the fetlock joint. A fourth steer in the pasture had both limbs as high as and including the fetlock joint stiff and cold. Still another animal was lame in the hind limb. Seven herds within a radius of 4 miles had suffered. Six abortions were reported.

April 24 and 25 I visited a number of the diseased herds in Effingham and adjoining counties in Illinois. The farm of Lemuel Faunce is situated 10 miles northeast of Effingham and one and one-half miles from Montrose. The first cases appeared in the latter part of December, and began with diarrhea and other signs of digestive disturbance. There were 21 head of cattle on the farm and no new ones had been purchased at the time of or immediately preceding the outbreak. Two cows, each of which had both hind legs affected, had been killed before my visit; 1 steer has a hind limb off at the fetlock; another has a clear line of demarcation formed at the fetlock, the part below being gangrenous; a bull has lost both toes from one foot and one toe from the other; 2 other animals were very stiff. One steer had two attacks and another had three attacks of lameness, and the latter entirely recovered. The animal that was first to suffer still had sores, *i. e.*, erosions of the mucous membrane on the upper lip and gums exactly like those which I saw when examining the affected cattle at Neosho Falls and at Kirksville, though four months had elapsed since the appearance of the disease. Some of the sick ones had slavered and smacked the lips, showing that the mouth was quite severely affected.

The horses on this farm had also been troubled with an eruption in the mouths which had caused salivation and loud smacking of the tongue and lips. These were now entirely recovered, though slight evidences of the sores on the lips were still visible. The horses were seen to have lost appetite in January or early in February. The last of February sores were observed in the mouths, and it was six weeks before these healed. Only one hog was kept, though many of the neighbors' hogs had been continually running around the pastures. None of these had been affected.

Three miles north and 1 mile west of Mr. Faunce's farm, Mr. Dubroc had yearlings in a high, dry lot, in which was an out-house for shelter, parly filled with hay. All of these were affected and all recovered. There were here 160 head of cattle, only 8 or 10 of which, all told, were lame. Ten or 12 goats were running with the cattle, but remained well; the two places mentioned above were so situated on different roads that there was little if any passing from one to the other, and the outbreaks were therefore independent of each other.

Other cases of the disease occurred on the farm of Mr. John Mason, who lives near Wheeler in Jasper County. This gentleman owned 120 head of cattle, of which 17 had been affected. Six animals were so bad that they had been killed; 2 others remained, one of which had lost a foot, and the second one would lose both of the posterior feet at or above the fetlock; a part of the tail of this one was also gangrenous. Nine others had been more or less lame but had lost no limbs. On this farm and in close proximity to the cattle were 25 horses and mules, 100 hogs and 40 sheep, all of which had been free from disease.

In the town of Wheeler, a single family cow was found with the lower parts of the posterior limbs separating as a result of dry gangrene. This seemed to be the only sick animal in the town.

Mr. Keating, who lives 6 or 8 miles from Effingham, had also suffered from the same disease. His herd consisted of 45 young cattle and 6 cows. None of the cows were affected, and it is worthy of remark here that they had been fed upon hay harvested in 1882. The young cattle were fed upon the crop of 1883, and of these 8, which were in a very bad condition from the loss of their limbs, had been killed; two others were still alive with the feet off at the fetlock. About half of the 45 young cattle were more or less affected. There were 60 sheep and a number of hogs on this farm, none of which had shown any signs of disease. The cattle here were attacked about the 8th of January.

These farms are mentioned as examples of what had occurred at seventeen or eighteen different places that I learned of within a radius of 15 miles from Effingham. As a matter of great interest connected with this subject, I was informed by a number of people that there had been a greater number of abortions among mares, and more cases of difficult parturition during the past winter and spring than was ever known before.

Other herds were reported on good authority to be affected in the same manner at different points in Missouri, Illinois, Iowa, and Colorado.

CLASS, CONDITION, SURROUNDINGS, AND CARE OF THE ANIMALS.

All the diseased animals on the farms visited by me were stock cattle in medium to thin condition. Those worst affected, in which one or more limbs were separating as a consequence of dry gangrene, had evidently lost much flesh during the progress of the disease. There were no fat cattle on any of these farms. At Mr. O'Toole's it was said by those who visited the place the fattening cattle were attacked as well as the stock cattle and calves.

On most of the farms there were cattle of all ages—calves, yearlings, two-year-olds, three-year-olds, and cows. The calves and yearlings seemed to escape in a greater degree than the older cattle. In the Goodrich herd were 20 calves which occupied a lot through which the other animals were frequently driven to water and into which some of the lame ones were placed. This lot was separated by an open fence from that in which were kept the worst diseased animals of the herd, and yet not one of the calves suffered in the least. At Pribbernow's were 54 yearlings running with the other cattle, and from which the worst affected ones were only separated by a rail fence, and all of these escaped. At Keith's were 2 young calves sucking diseased mothers, but themselves in good health. Here also were hogs and a litter of young pigs running in the same lot with the sick cattle, but free from any signs of disease. At Kirksville sheep had been running with the cattle and were also healthy. In Illinois, sheep, swine, and goats mingled with the affected herds with perfect safety.

The winter has undoubtedly been a severe one upon the stock of the Western States, and the cattle were consequently somewhat below the average condition at this season of the year. The appearance of the disease cannot be explained by this fact, however, since thousands of healthy herds were in worse condition than those on the farms in question. Some of these herds, and noticeably that of Goodrich, were in much better than average condition; they had evidently been well fed and cared for.

There was nothing in the surroundings of the affected animals which would explain the development of the disease. The feeding lots in most cases were unusually dry and the disease had appeared at a time when all mud was frozen sólid. The soil did not contain enough alkali, even at Neosho Falls, to make it at all probable that this could have been the exciting cause of the disease. As is usual in the management of cattle at the West, the herds were without shelter. At Keith's the cattle lots were in a ravine protected by timber; on some of the farms there was little protection of any kind. Such a condition, however, is so common that it could not be regarded as having much influence in the production of this trouble. All of the affected herds seem to have received ordinarily good care. Keith had fed some of his cattle shelled corn and mowed oats in addition to hay. Pribbernow had fed his yearlings on millet, oats, and corn-fodder, and consequently they had eaten less hay. Beard had fed shocked corn. In Illinois, Keating had fed liberally on corn. On most of the farms the water was very good, but probably deficient during the cold weather. Keith had pumped water from his well; Goodrich's cattle drank from a pond; Beard's from the river, and Pribbernow's from a creek. It was necessary to cut holes through the ice and these would soon freeze over; consequently, it may be admitted that in most cases there might have been a deficiency of water.

When the animals first became lame it was supposed that mud had collected between the toes, and, becoming hard, was producing irritation. The animals were caught and their feet cleaned, but this had no effect on the development of the disease. It is evident that the animals were cared for as well as is ordinarily the case in this section of the country, and that the slight deficiency of water and the exposure to cold were accessory rather than the exciting cause of the disease.

SYMPTOMS AND CHARACTERS OF THE DISEASE.

The first symptoms of disease in the Illinois epizootic were diarrhea, lameness, stiffness of the lower joints of the affected limb, and coldness and insensibility of the same parts. In Kansas this derangement of the digestive apparatus was not noticed. At all the places visited, however, the lesions of the feet were of a common character and were produced by a common process. In the more severe cases a constricted band formed around the limb at the point separating the gangrenous from the living flesh. So marked was this constriction that some of the owners looked upon it as the initial lesion of the disease and cut across it with a knife in the hopes of re-establishing the circulation. It is needless to say that this hope was delusive, since the part below the constriction was entirely lifeless before this was formed. The constriction was the first step in the effort of nature to rid the body of parts that were of no further use to it.

The next step in the process of separation was a crack in the skin at the upper edge of the band of constriction, which gradually extended toward the center of the limb, the softer parts dividing first and the tendons and ligaments resisting much longer. Generally this separation was in the vicinity of a joint, and in this case, as the lower members of the limb were lost a comparatively even surface was left which healed readily. Some animals lost only a toe, the dividing line passing through the joint between the *os pedis* and *os coronæ*; others lost both t *os pedis* and *os coronæ*; still others lost the three lower bones, and t line of separation passed through the fetlock joint, while in the

most severe cases the line of constriction formed at the upper third of the metatarsal bone and the fleshy parts sloughed off, leaving the uncovered bone protruding for more than half its length. Plates V and VI are drawings made from limbs which I secured in Kansas.

It was reported by some of the veterinarians that small vesicles were formed in the interdigital space and about the coronet, and this was doubtless true, as such vesicles are not uncommon in gangrene; but their appearance was far from being the rule, as I did not succeed in finding a single one in all the animals that I examined. In nearly all of the cases, whether the foot was affected with dry gangrene or whether there had been simply lameness without death of the part, the skin of the interdigital space and about the coronet was perfectly preserved. There was loss of neither epidermis nor hair, as there certainly would have been had the disease commenced by a superficial inflammation in this region and extended to deeper parts of the foot or to higher parts of the limb. Indeed there were no abscesses, no burrowing of pus, no ulceration about the feet, which could lead one for a moment to suppose that the cause of the disease had commenced its action externally and extended gradually to the interior of the limb. On the other hand, the fact that the skin was intact in the great majority of cases, that the part was cold and insensible almost from the first, and that the line of separation passed entirely through the limb, removing one or more phalanges as completely as it could have been done with a knife, was sufficient evidence that the disease had an internal origin.

The gangrene was not confined to the feet, however, for in Kansas, Missouri, and Illinois there were individual animals which were losing from 2 to 6 inches of the lower part of the tail by exactly the same process. The portion below the dividing line was very dry and hard, while the line itself was sharply defined, as though it had been a knife-cut. With the greater part of the animals affected in the feet a careful examination of the end of the tail revealed a slough of greater or less extent; sometimes it was simply the skin at the tip that was affected, but oftener one-half inch, 1 inch or 2 inches would be found discolored, lifeless, and dry. In a very few cases a part of the ear was found in the same condition.

One of the most interesting features of the enzootic, because it had not been heretofore described, was the implication of the mucous membrane of the mouth. With some animals this was limited to a more or less diffuse red discoloration, without loss of substance. More frequently there were circumscribed dark red spots or patches, from a fourth of an inch to an inch in diameter. Very often there was loss of substance—erosions from a third to a half inch in diameter. Some of the veterinarians reported that they had discovered blisters in the mouths, and it is not unlikely that these erosions in their first stages were more or less vesicular in character, but I was not fortunate enough to see them in this stage at any of the places visited. In some animals the part of the membrane that was being lost was still attached by shreds, in others it was entirely removed, but in no case did I see anything of the nature of a vesicle. None of the erosions presented the appearance of ulcers, or showed any considerable inflammation. They were dark-colored, the borders were not elevated, and the surrounding blood-vessels were neither prominent nor injected. It appeared to be only the superficial layer of the membrane that was involved.

In a very few animals a lesion of a different character was observed in the mouth. In these cases an irregular patch of mucous membrane from 1 to 2 inches in diameter was elevated, corrugated upon its surface,

hard, insensible, and of a light color, tinged with pink and yellow. It seemed to be a circumscribed gangrene of the mucous membrane, the dead parts being partially decolorized by soaking in the fluids of the mouth.

There was also an evident irritation of the mucous membrane of the posterior parts of the alimentary canal and organs of generation. That covering the rectum and vagina was generally red, covered with mucus, and presented spots denuded of the epithelium. In Missouri six cases of abortion in cows were reported, and in Illinois there were many cases of abortion and difficult parturition with mares.

The constitutional symptoms were not very marked. The temperature of the animals which I examined was about normal, with the exception of a few from which one or more limbs were sloughing and with which there was suspicion of septic poisoning. Drs. Holcombe and Trumbower observed high temperatures (104 to 104.8 degrees) in some cases in the early stages of the affection.

In those animals which recovered after showing lameness there was no loss of substance or inflammation of the skin as would have resulted from freezing to a sufficient depth to cause lameness. In these animals the lameness and stiffness of the lower joints were the only symptoms of the disease in the feet, though the same animals frequently showed erosions in the mouths.

EVIDENCE POINTING TO ERGOT AS THE CAUSE.

In each of the herds which I visited, with the single exception of Beard's, there were typical cases of dry gangrene of the extremities, with an evident preference for the posterior limbs. In the most severe cases there was complete death of the leg as high as the middle portion of the metatarsal bone. This dead part was sharply defined, first by a constriction and later by a crack from the living flesh above. It was not a death of the superficial structures alone, but the skin, tendons, and bone were all involved, and every part of the leg below the line of separation just referred to was completely lifeless. A study of these legs showed very clearly that the disease had not begun at the hoof or in the interdigital space and progressed upward, for these parts had not been changed by disease of any kind previous to the death of the whole affected part, which had evidently occurred very suddenly. To my mind this condition made it very plain that the trouble was not the result of any disease which had begun in the interdigital space, or in the skin around the coronet. There could be no mistaking the fact that the worst affected animals presented typical cases of dry gangrene, and the problem to be solved was to determine which of the conditions that these animals were subjected to would satisfactorily account for the enzoötic. When we turn to veterinary literature for information in regard to the accepted causes of dry gangrene, we learn that there are very few agencies which are liable to affect a number of animals at a time and are capable of producing this effect. Compression, burning, caustics, plugging of blood-vessels, and ergot about completes the list of those that would be at all likely to produce dry gangrene in young animals, and of these the last is the only one that could have possibly been instrumental in developing the outbreaks in the West.

The peculiarities of the disease led me to examine the feed to learn if any unusual quantity of ergot could be found. The result of this examination was to show that at every one of the farms where the diseased cattle were located, hay had been fed which contained one or

more grasses ergotized to an extreme degree. At Keith's, Beard's, and Pribbernow's, in Kansas, there was a large proportion of wild rye (*Elymus virginicus*, variety *submuticus*) which contained an extraordinary quantity of ergot. In many heads half the grains and in other heads every grain had been replaced by the fungus. Careful weighings of heads brought to Washington, and from which some of the ergot had been lost in transit, gave in one case 12 per cent., and in another case 10 per cent., as the proportion of ergot. Now, if the head represented one-half the weight of the entire plant, from 5 to 6 per cent. of the weight of the rye must have been ergot; and if one-fifth of the weight of the hay was made up of wild rye, then a 20-pound ration of hay would contain about 4 ounces of ergot.

As is always the case where an attempt is made to account for results when the conditions affecting these have not been intelligently observed and carefully recorded at the time, we found some apparent discrepancies in the ergot theory. The greater part of these have been explained in a remarkably satisfactory manner, and if we could know every circumstance connected with the feeding and care of the animals for thirty or forty days preceding their illness, doubtless the most critical could be satisfied as to the cause of the disease in every subject. As we are compelled, however, to rely upon the more or less defective memories of the owners of the cattle, who, of course, did not make their observations in the light of subsequent developments, we must accept the situation as we find it and consider ourselves fortunate if a connection can be traced between cause and effect in the greater part of the cases. An exact estimate could not be made of the quantity of ergot in a given quantity of the hay in Kansas, but the weight of ergot in the heads of wild rye indicated this very closely. The head shown in Plate VII, Figure 3, is a good representation of this plant as it existed in the hay.

In Missouri the hay was made up mostly of red top (*Agrostis vulgaris*), but also contained some blue grass and timothy. The red top and blue grass contained a very large proportion of ergoted grains, and an occasional head of timothy was also affected. Figures 1, 2, and 4, Plate VII, are drawings from specimens of these grasses taken from the hay-racks at which the diseased cattle were eating.

In Illinois the hay was almost entirely composed of red top, and this contained a relatively large amount of ergot. Careful weighings of specimens of this hay and the ergot which it contained, from two of the worst affected farms, demonstrate that every 75 pounds of hay contains 1 pound of ergot; or, in other words, an animal eating 20 pounds daily of this hay consumed 4.2 ounces of ergot. Doubtless this quantity might be taken daily for a considerable time without producing appreciable effects under some conditions, but when the circulation in the extremities is diminished by extremely cold weather, and when in addition to this the water supply is limited then ergot in this dose, continued day after day, becomes very dangerous.

In Kansas I examined the hay on adjoining farms where no disease had appeared, and I found a very much smaller proportion of ergot. At the Dibble farm, which joins Keith's, one might examine a dozen heads of rye without finding a grain of ergot, and the same was true of hay found in the town of Neosho Falls. In Illinois, at two farms, I saw hay of the crop of 1882 and also that of 1883, and while the former contained some ergot the latter contained a greatly increased proportion. It had been noticed by the people here that the red-top hay of the crop of 1883, for some unexplained reason, was greatly inferior; that animals neither relished it nor thrived when fed upon it, and it sold for $3 a ton when

other hay would bring $10. At Keating's the animals fed on the hay of 1882 escaped the disease entirely, while those fed upon the hay harvested in 1883 alone suffered.

Evidently the year 1883 was a favorable one for the production of ergot over a very large area of the Western States, but the local conditions of soil and situation and the time of cutting the hay had a very great influence on its development. All of the ergoted hay of the affected farms in Kansas was cut from bottom lands, and in Missouri and Illinois it was grown on very level prairies the drainage of which was very imperfect. Again, the early cut hay was comparatively free, when that allowed to ripen was badly affected.

In brief, then, our reasons for considering the disease to be ergotism were, first, the character of the lesions, which were such as have always been ascribed to ergotism in the past, and as could scarcely be produced in so many animals from any other known cause; and, secondly, the extraordinary proportion of ergot found in the food of the animals on every affected farm.

It is very probable that the cold weather had a considerable influence in developing the effects of the ergot, and the greater part of the cases were first noticed during or soon after such weather. Many cases occurred soon after a severe ice storm or sleet. Again, with the appearance of milder weather new cases ceased to appear, although the same hay was still being fed. The two or three new cases in Missouri were the only exceptions to this statement.

I have no doubt, therefore, that the cases which I investigated, and the similar cases which occurred about the same time in other localities, were cases of ergotism. Professor Law, of Cornell University, Professor Stalker, of the Iowa Agricultural College, and Professor Faville, of the Colorado Agricultural College, have seen similar cases in their respective States, and concur in the opinion that they are due to poisoning from ergot.

CHARACTERS WHICH DISTINGUISH THIS DISEASE FROM EPIZOOTIC APHTHA, OR FOOT-AND-MOUTH DISEASE.

History.—The foot-and-mouth disease of Europe is a specific fever which only arises by contagion from other affected animals. In the whole history of America there have been no spontaneous outbreaks of this disease, and in Europe the conviction is growing stronger every year that it has no other cause than contagion. We may accept it, therefore, as a fact that foot-and-mouth disease cannot occur in the United States except by the introduction of virus from abroad.

When a disease having some resemblance in its symptoms to foot-and-mouth disease is found in the interior of our country, more than a thousand miles from the ports where the contagion must necessarily be introduced, it becomes a matter worthy of the most careful consideration to determine if there was any means by which this contagion could have been transported to the affected herd. When a contagious disease is spread broadcast over a country it may be difficult or impossible to trace many outbreaks; not so, however, with a single outbreak produced by so virulent a contagion as that of the disease under consideration. In such a case it would be remarkable if it could not be traced.

In the present instance the animals of the affected herds had been purchased or raised in the neighborhood; no foreign animals or people had been upon the farm where the first attacks occurred. Foreign cat-

tle had for a long time been quarantined at the sea-board a sufficient time to make it impossible that this disease could have been carried by them to the West. It was absolutely impossible to find any satisfactory manner by which a foreign contagion could have been introduced.

This important indication seems to have been greatly neglected in deciding upon the nature of the disease in Kansas. It was said if this is foot-and-mouth disease we must acknowledge that we have it, whether we can trace its introduction or not. Plausible as this reasoning may seem we must admit that it is not always an easy matter to diagnose a disease off-hand from its superficial characters. And in the diagnosis of contagious diseases we must remember that the symptoms are but the expression of the effects of the virus, and that these symptoms may be simulated more or less closely by other agencies acting upon the animal economy.

The history of the origin of any disease believed to be contagious is, then, a most important part of the evidence to be taken into consideration before a diagnosis is reached. We may take contagious pleuro-pneumonia for example. Many cases of this disease resemble so closely spontaneous inflammations of the respiratory organs in cattle that it is absolutely necessary before a diagnosis can be reached to inquire if the contagious pleuro-pneumonia has been introduced or if the malady occurred spontaneously. The same principle holds good to a greater or less extent with other diseases, and it may be safely asserted that when the history does not receive proper consideration many mistakes will be made that otherwise might be avoided.

Contagiousness.—The virus of foot-and-mouth disease is one of the most active contagions known. The period which elapses between exposure and the appearance of the first symptoms of the disease is, as a rule, but two or three days; a very large proportion of exposed animals become diseased, and the plague spreads rapidly from farm to farm. As a result of these characters, within a week after the introduction of foot-and-mouth disease into a herd nearly every animal in that herd shows unmistakable evidences of having contracted it. A very small proportion of the animals may resist the contagion, but this proportion is much less than with most other contagious diseases, and is so small that it does not affect the rule just mentioned.

The disease at Neosho Falls showed very different characters from this. Goodrich's herd suffered in the largest proportion, 65 out of 96, or 68 per cent., being more or less affected. The first case here occurred January 10, and no others until February 15, or more than a month later. After this new cases continued to develop for two or three weeks. But in a lot adjoining that in which the sick cattle were placed there were 20 calves, which remained entirely free from disease. The isolation of these calves was not sufficient to hold foot-and-mouth disease in check for a single day; it was even said that the sick cattle had been driven through the calf lot to water, and that some of the smaller ones, when attacked, were placed with the calves.

At Keith's 74 out of a total of 118, or 63 per cent., were affected. At the end of the first week but 20 or 30 head had been attacked, and from this time new cases continued to appear until March, or during a period of two months. Here also it is to be remembered that in a lot of animals separated from the sick ones by a simple rail fence there was no appearance of disease until two months after it had attacked the first lot. Hogs were running in the lot with the worst cattle; they even ate the blood of the slaughtered ones and nibbled at the affected feet, but they did not suffer in the least. A sow had brought

forth a litter of pigs in a shed which forms a part of the inclosure, and these were doing well. Two calves were sucking mothers under the influence of the disease but were themselves in good health.

At Pribbernow's only 8 per cent. of the animals had been attacked, and among a lot of 54 yearlings running with the other cattle there was not one case of disease.

At Beard's, in a herd of 75, the first animal was lame a week before the second was affected; and then another week passed before the others showed any symptoms. Here only 6 per cent. of the cattle on the farm were attacked, and one died within twenty hours from the appearance of the first symptoms.

At Kirksville the proportion of animals that suffered was not definitely ascertained, but there was no evidence of contagion, and sheep running with the affected cattle remained healthy.

In Illinois, on the Faunce farm, the horses suffered from an eruption in the mouth. The exact nature of this disease it was impossible to ascertain at the time of my visit. It may be remarked, however, that horses seldom suffer from foot-and-mouth disease; and that this is the only case which came under my notice on any of the affected farms where any other animals than cattle showed symptoms that were even suspected to be in any way connected with the disease among the cattle. In this instance the eruption in the horses' mouths could not have resembled foot-and-mouth disease very closely, for it remained at least six weeks, or three times the period of the latter disease. Here the neighbors' hogs which were running around the farm failed to contract any disease or to carry it to other farms.

At Mr. Mason's there was still more striking evidence to show that the disease was very different from epizootic aphtha. One hundred hogs and 40 sheep had been exposed, and not one suffered. Only 17 bovine animals out of 120, or about 15 per cent., showed any signs of the disease. At Keating's, 60 sheep and a number of hogs were exposed but all remained well. At Dubroc's, goats were exposed without suffering.

The disease, therefore, did not resemble foot-and-mouth disease either in the proportion of the animals attacked or its rate of extension, or in attacking other species of animals than cattle.

Occurrence at the same time on widely separated farms.—If foot-and-mouth disease had been introduced into the heart of the country in any of the extraordinary ways which were offered to explain its appearance, we surely cannot conceive of its being brought to so many widely separated points at about the same time, especially where there had been no communication between these places. In Kansas there were the Keith, Goodrich, and Beard herds which might be grouped together; 14 miles from these was the Pribbernow herd; 20 miles from any of these was the cow at Hall's Summit; across another space of 15 miles was the O'Toole herd; then it was necessary to travel nearly 200 miles to reach the Osborne County cases. Again, the same disease undoubtedly existed at several points in Iowa, Illinois, and Missouri. There had been no communication between these places, and if we assumed that they were the result of a foreign contagion it was necessary to conclude that a considerable number of independent introductions of this had occurred at very nearly the same time. This assumption, in view of the difficulties in the way of introducing a contagion to the interior of the country, and the impossibility of tracing such introduction at this time, was so improbable that it could scarcely be admitted even if all other evidence had pointed to foot-and-mouth disease.

Comparison of symptoms.—The symptoms of foot-and-mouth disease are constitutional and local. The constitutional symptoms are loss of appetite, elevation of temperature, and other signs common to fevers. The local symptoms consist in an eruption of blisters in the mouth, between the toes, about the coronet, and on the udder and teats. In order to understand the difference in symptoms between the recent disease in the Western States and foot-and-mouth disease, it is necessary to examine each of those points separately.

The constitutional symptoms.—In foot-and-mouth disease there is usually a very marked increase of temperature, reaching from 104° to 107°. At Neosho Falls the temperature, as a rule, did not exceed what might reasonably be expected in health. Some of the perfectly healthy yearlings had a temperature of 103°, while that of most of the sick ones was below this point. One of the steers in the early stages of disease at Keith's showed 104.4° on March 9, which was about the highest point reached by any. In foot-and-mouth disease there is loss of appetite and difficulty of swallowing, but here the universal testimony was that the appetite had remained good throughout and there was no trouble in mastication or swallowing. In Illinois there were marked symptoms of digestive disturbance, and the disease was ushered in by diarrhea.

The mouth symptoms.—In foot-and-mouth disease there is an eruption of blisters on the mucous membranes of the lips, gums, tongue, and palate, which are numerous and painful. Often they unite with each other and form large patches, from which the covering becomes detached, leaving ulcerous patches of a bright red color and of great sensitiveness. It is almost impossible for animals in this condition to eat hay or other dry food, and it is necessary to support them with gruel. Such animals stand, making a peculiar and rather loud smacking noise with the lips and tongue, grinding the teeth and slavering profusely. In Kansas the mouth symptoms were much less severe than this, but two or three animals were reported to have had any salivation or any difficulty in eating hay. Some of the mouths presented erosions, which were mostly small, very superficial, and without any appearance of ulceration. I did not see a single blister, but a few of these were reported by those who visited the herds at an earlier date. The lesions which I saw in the mouths seemed to be due rather to a softening of the mucous membrane than to vesication; and I was assured that the appearances did not differ materially at the time of my visit from what they were when the veterinarians first saw them. In one or two animals there were large patches of thickened mucous membrane of a yellowish color, hard and difficult to detach. Healthy herds in the vicinity were visited, and in the mouths of these cattle were found discolorations and erosions very similar to, though less extensive than, those seen in the sick ones. In Missouri some of the cattle had the mouths involved to a greater degree than any I saw in Kansas, but others with equally bad feet had perfectly sound mouths. Here I saw pieces of mucous membrane becoming detached, but no blisters. Figures 1 and 2, Plate X, show the highly inflamed condition of the ulcers in the real foot-and-mouth disease.

The cattle in Illinois still had erosions in their mouths as late as April 24, which were identical in appearance with those I saw in Kansas. The steer which first came down with the disease on the Faunce farm, and which had consequently been affected about four months, showed these about as plainly as any animals I saw in Kansas. In foot-and-mouth disease the eruption disappears in from two to three weeks, and the animal is convalescent. Before proceeding to Kansas and Illinois the second

time, I visited the herds at Portland, Me., which had been affected with foot-and-mouth disease. The contrast was very striking. Although the cattle in Maine had not showed the disease until the second week in February, they were on the 16th of April in apparently good health. There were no longer any sores in the mouths or on the feet. A week later than this I found cattle in Illinois that sickened in December and still had as marked mouth symptoms as could be found in any of the Western herds.

The feet symptoms.—The interdigital spaces and the coronet are the seat of the eruption in foot-and-mouth disease. Not only is there redness, heat, and swelling in these parts, but there is formation of blisters, loss of epithelium, and a secretion from the whole affected surface of the skin. The appearance of the feet with sheep and cattle having this disease is shown in Figs. 1, 2, and 3, Plate IX. Sometimes abscesses form beneath the horn, from which the pus may burrow and cause the loss of the hoofs, or even affect the ligaments and joints. But severe complications in the region of the foot do not occur except from this cause. With the cattle which I visited, the feet presented a very different appearance. Some of the limbs were separating, as a consequence of dry gangrene, half way between the fetlock and hock joints, with the skin of the foot still in perfect condition, though dead. In others the separation occurred at the fetlock, and in many others at the joints below, but not as a consequence of the burrowing of pus. Indeed, very little pus was to be seen in any of the feet. It is not rare to see the horn of one or both toes lost in foot-and-mouth disease, but it would be remarkable for the whole toe, including the bone, to slough off, as occurred so frequently here. I did not see a case where the hoof was lost without a loss of the bone at the same time. The complete death of the foot to the fetlock, or even higher, as occurred in all the worst cases in the West, is altogether unheard of in foot-and-mouth disease. While there was redness, heat, and swelling above the line of separation, I saw no appearance of blisters between the toes or around the coronet. A large proportion of the affected animals were simply lame, and had neither blisters nor sores about the feet. Finally, the disease was generally confined to the hind feet, or, if it attacked a forefoot, it was only after both hind ones were affected. Foot-and-mouth disease has no such decided preference for the posterior extremities.

The eruption on the udder.—In only one case that I have heard of in the West was there any appearance of an eruption on the udder of the affected cow. This was a cow belonging to Mr. Keith, the young calf of which died, as was supposed from the effects of the disease contracted from its mother. I am unable to account for the sores which evidently existed on the udder of this cow, not having seen her until they were nearly healed. There is also considerable doubt as to the cause of the calf's death. Certain it is that an eruption of blisters on the udder is an extremely common occurrence in foot-and-mouth disease (Fig. 3, Plate X). In the West, however, a considerable number of cows were affected, and but one had any symptoms of this kind.

Reviewing these symptoms, we can see that the disease which I investigated had few if any characters in common with foot-and-mouth disease. Among the whole number there was not a single animal which presented the typical characters of this plague. There did not appear to be a single animal which presented even the typical mouth symptoms, or the typical feet symptoms of that disease. The history, the charac-

ters, the symptoms, everything connected with the disease, led us to conclude, therefore, that it could not be the contagious foot-and-mouth disease.

CHARACTERS WHICH DISTINGUISH THIS DISEASE FROM FOUL-IN-THE-FOOT.

The disease known as foul-in-the-foot, and often called foot-rot, has its origin in the skin of the interdigital space. It begins as a superficial inflammation, which is followed by sloughing, ulceration, suppuration, the burrowing of pus, and the formation of sinuses. By this process the disease may gradually extend beneath the horn of the toes and toward the deeper parts of the foot, until the tendons, bones, ligaments, and articulations are involved. In extreme cases it may even extend to or above the fetlock joint. Steel, in his new work on the "Diseases of the Ox," sums up this characteristic of the disease as follows:

> Thus the pathological conditions of this disease are, at first, the existence of inflammation in the interdigital substance, which may be partially removed by sloughing, then the presence of pus beneath the hoof-horn, boring and forming simple sinuses, which extend outwards and burst on the surface. The patient is very lame, and the digits are separated from one another in a remarkable manner.

That is, foul begins between the toes, forms sores there, and these slowly extend by ulceration and the burrowing of pus. Neither in Kansas, Missouri, nor Illinois were any such pathological characters as these seen. There was sudden and complete death of a toe or of a foot, or in some cases of a leg as high as the hock joint; the disease showed no tendency to extend, but was limited by a groove around the limb, which soon became a crack, and the affected portion was sloughed off. There was no burrowing of pus, no ulceration, and when the lifeless portion of the limb had separated, the stump healed as readily as could be expected. The disease was dry gangrene beyond question, and dry gangrene is not produced by foul-in-the-foot.

Again, those who so confidently pronounced the disease to be foul, overlooked the gangrene of the tails, which was present in a large number of cases, and was most marked in those animals in which the feet were most severely affected.

Finally, the digestive disturbance and the lesions in the mouths were too evidently connected with the disease in the feet to be left entirely out of consideration.

It is surprising that two diseases having such different symptoms could be confounded, and the mistake of such a number of competent veterinarians can only be explained on the supposition that the examination was hurried and superficial, and that ergotism among animals has received but little attention in English-speaking countries.

OBJECTIONS WHICH HAVE BEEN URGED AGAINST THE THEORY OF ERGOTISM IN KANSAS.

When we first diagnosed the disease at Neosho Falls to be ergotism, we were met by the objection that ergotism could not occur without ergot in the food, and that this condition did not exist on the affected farms. It required but a few minutes inspection of the hay racks, however, to satisfy the most skeptical that the hay at Keith's, Beard's, and Pribbernow's contained a large quantity of ergot in the wild rye which made up a considerable proportion of the forage. And subsequent examination has proved its existence nearly everywhere that this disease occurred.

The second objection was that ergot did not produce dry gangrene in animals; and this statement has been repeated again and again by professional men who certainly ought to have known better. The quotations from standard authorities as to the effects of ergot and the historical compilation contained in other sections of this report will be sufficient, I believe, to satisfactorily dispose of these assertions.

Again, it was said that it required enormous quantities of ergot to produce appreciable effects on cattle, and even if it could in that case cause dry gangrene, the quantity found in the Kansas hay was totally insufficient to account for these results. To this I reply that ergot in different seasons is known to differ widely in its poisonous qualities; that certain conditions, such as extremely cold weather and deficiency of drinking water, undoubtedly increase its effects in a very important degree, and that, finally, we do not know how much is actually necessary to cause dry gangrene. Careful estimates of the quantity of ergot in the hay in Illinois, Missouri, and Kansas show that these cattle must have taken with their food from 3 to 4 ounces of this poison each day. The dose of ergot recommended by standard veterinary authorities as safe for medical purposes is about one ounce for grown animals, but it is not expected that this would be used for more than one or two days together. The diseased cattle, therefore, had taken from three to four full doses of ergot a day, and continued this for days and weeks. Considering that the action of ergot is to diminish the caliber of the blood-vessels, that the gangrene of the extremities is directly traceable to deficient blood supply, and that atmospheric cold also has a marked tendency in this direction; that, in addition to all this, the drinking places were frozen over, and the holes that were cut through the ice were only kept open a short time each day, it would appear that the conditions were very favorable for the development of ergot poisoning.

Then it was reported that the outbreak in Osborne County was certainly the same disease, and that the cattle had been pasturing on green rye and consequently could not get ergot. A few inquiries brought out the fact, however, that the rye pasture had only been in use for three weeks, while the disease had appeared at least six weeks previously. There was no reliable information as to what these cattle had been eating before the appearance of the disease, and the forage was not examined by any competent person.

"If this disease is due to ergot poison," says one gentleman, "why then is this the first outbreak, since the Kansas farmers have fed this same kind of hay to their cattle from the first settlement of the State?" But who knows that they have ever before fed hay containing as much ergot? In Europe the enzoötics of ergotism have at times been a century apart, and it is a well known fact that it is only in occasional years that these enormous quantities of ergot are produced. Then how can it be known that this is the first outbreak of the disease in Kansas? Cattle have frequently suffered with the same symptoms in New York, Pennsylvania, Iowa, and Missouri, and why not also in Kansas? Who outside of the immediate vicinity of the suffering herds would have heard of the outbreak under consideration had it not been for the mistaken diagnosis that led the country to fear the presence of a dangerous contagious disease?

Again, would not this reasoning apply to any supposed cause of the disease as well as to ergot? No matter what produced the disease, if such an outbreak has never occurred before it might be said with just as much force, "Why, then, is this the first outbreak?"

"Again," the same gentleman goes on to say, "on Mr. Goodrich's

farm, where the disease prevails, the lands are improved by cultivation, and there is no ergotized rye in his hay. Yet out of 96 cattle, 40 head of young stock are reported affected with the disease." This fact was the most troublesome of all I had to contend with in making my diagnosis, and I appreciated its importance perhaps as much as my critics could have appreciated it. The gentleman's statement is not absolutely correct, however, as there was a small quantity of ergoted rye in the hay; but still there was so much less than was seen at the other farms as to make it impossible to explain why the cattle here should be affected even to a greater degree than elsewhere. In my preliminary report I explained this by saying that wild rye was known to grow in patches, and that, consequently, hay that was being fed at one time could not be considered as exactly the same as that fed three months before. The apparent discrepancy in this case has since been explained, however, in a much more satisfactory manner. Some time last fall Mr. Goodrich bought two stacks of hay of Mr. Keith, and it was this hay that he had been feeding to his cattle up to the time of the outbreak of the disease. When this fact was learned the whole matter became perfectly clear, and what at first appeared the greatest objection to the ergot theory turned out to be one of its strongest supports.

Then Mr. Beard is mentioned as having fed 75 head of cattle all winter on hay full of ergot, and escaped with but 5 diseased animals. Mr. Beard, however, had fed his cattle twice a day on corn-fodder, that is, on corn which had been shocked but not husked, and as a natural consequence his cattle ate very much less of the hay.

"Stranger still for the ergot theory, Mr. Pribbernow fed 195 cattle on millet hay and corn-fodder, and he has 14 of his young stock affected." Here, again, the zeal of the gentleman to make out a case against the ergot theory has led him to make statements which are not correct. Mr. Pribbernow had some very badly ergoted hay, which he showed to me, and told me that he had been feeding it to his cattle; and, indeed, there was plenty of evidence that this was the case from the condition of the feeding yards and racks. It is a fact, however, that 54 yearlings were fed on millet hay, oats, and corn-fodder in addition to the hay, and that not one of these was affected. The older cattle had been fed more exclusively on the hay, and it was among them alone that the effect of the ergot was seen. These facts I noted down as they were related to me on the spot by Mr. Pribbernow.

"Another puzzle is presented by Mr. Keith buying 63 head of young stock from Mr. Davis on the 15th of December, and on the 23d nearly all were down with the disease. Keith's hay contains ergotized rye. Davis has had no sickness in his herd." This statement is also very incorrect, and yet it contains a reference to the one unsolved difficulty connected with the Kansas outbreaks. The 63 head of cattle were purchased December 10, and as the first cases of sickness on this farm did not occur until the 23d or 24th, and as at the 1st of January there were still less than thirty cases all told on the farm, it is plain that these animals had sufficient time to contract the disease after their purchase.

The difficulty in regard to the ergot theory at Keith's was in connection with another lot of cattle bought about the 15th or 20th of December. This lot consisted of 6 yearlings and 2 cows, some of which Mr. Keith asserts were sick within three days and all within eight days, and that they were not fed upon hay during that time, but upon mowed oats and corn-fodder. He admitted, however, that there was probably hay in the racks to which they had access. There was much doubt as to the days on which these cattle were first seen to be lame, and as to

how severely they were affected. It is also impossible to say, at this time, on what they had been fed previous to their purchase. This difficulty, however, does not compare with that felt at first in regard to the Goodrich herd, and as the latter was satisfactorily explained at the last minute, it is not at all improbable that there are some unknown facts in regard to the 8 cattle in question that would explain this case just as satisfactorily.

I have reviewed above the chief objections that have been advanced to show that the disease in Kansas could not be ergotism. It is unnecessary to add that they are mostly of the nature of captious criticism. The malady had been pronounced foot-and-mouth disease by some and foot-rot or foul by others, and these gentlemen found it desirable to make out at least an apparent case against ergotism. In other sections of this report I have given abundant evidence to show that it could be nothing but ergotism, and the plates herewith presented, which were carefully prepared by a competent artist, are sufficient to prove this beyond doubt to any one who understands the pathology of these different diseases.

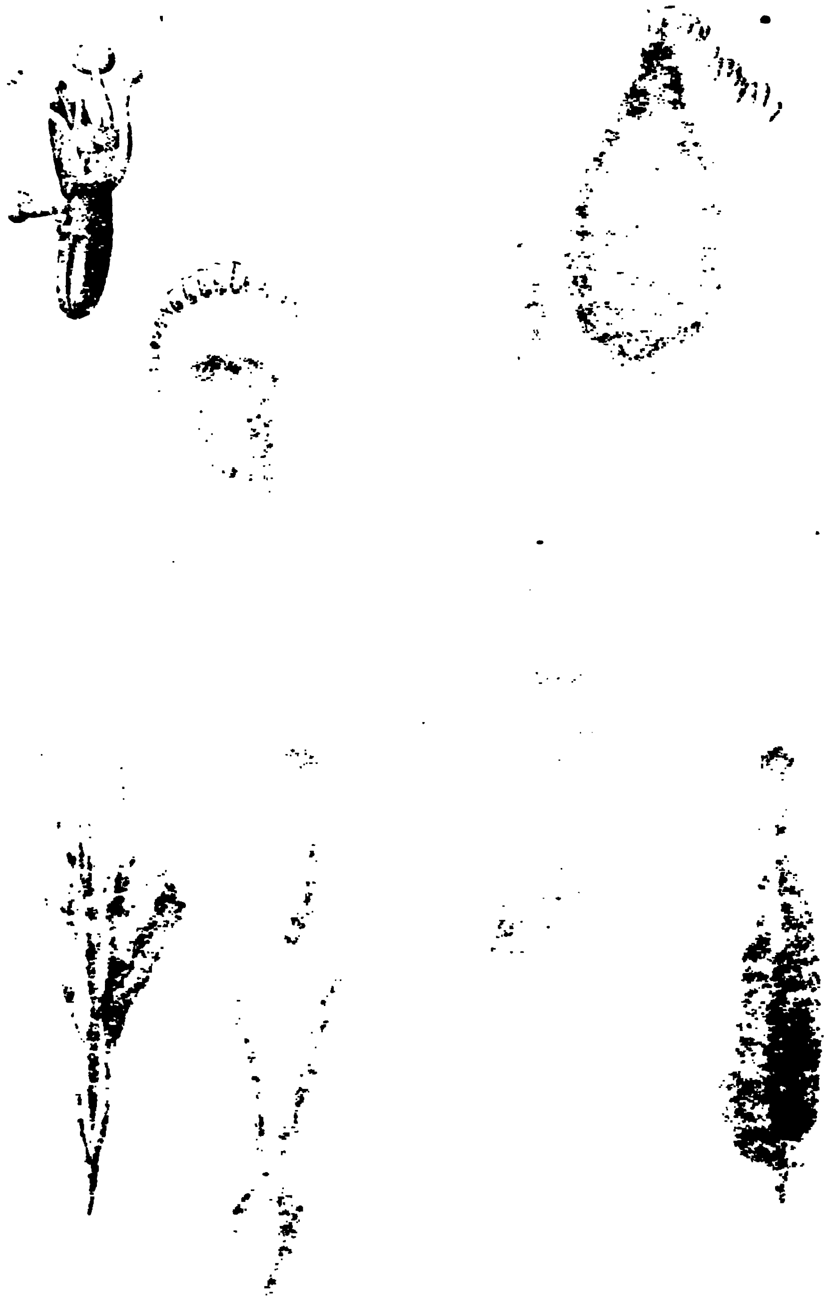
THE NATURE, CHEMICAL COMPOSITION, AND ACTION OF ERGOT.

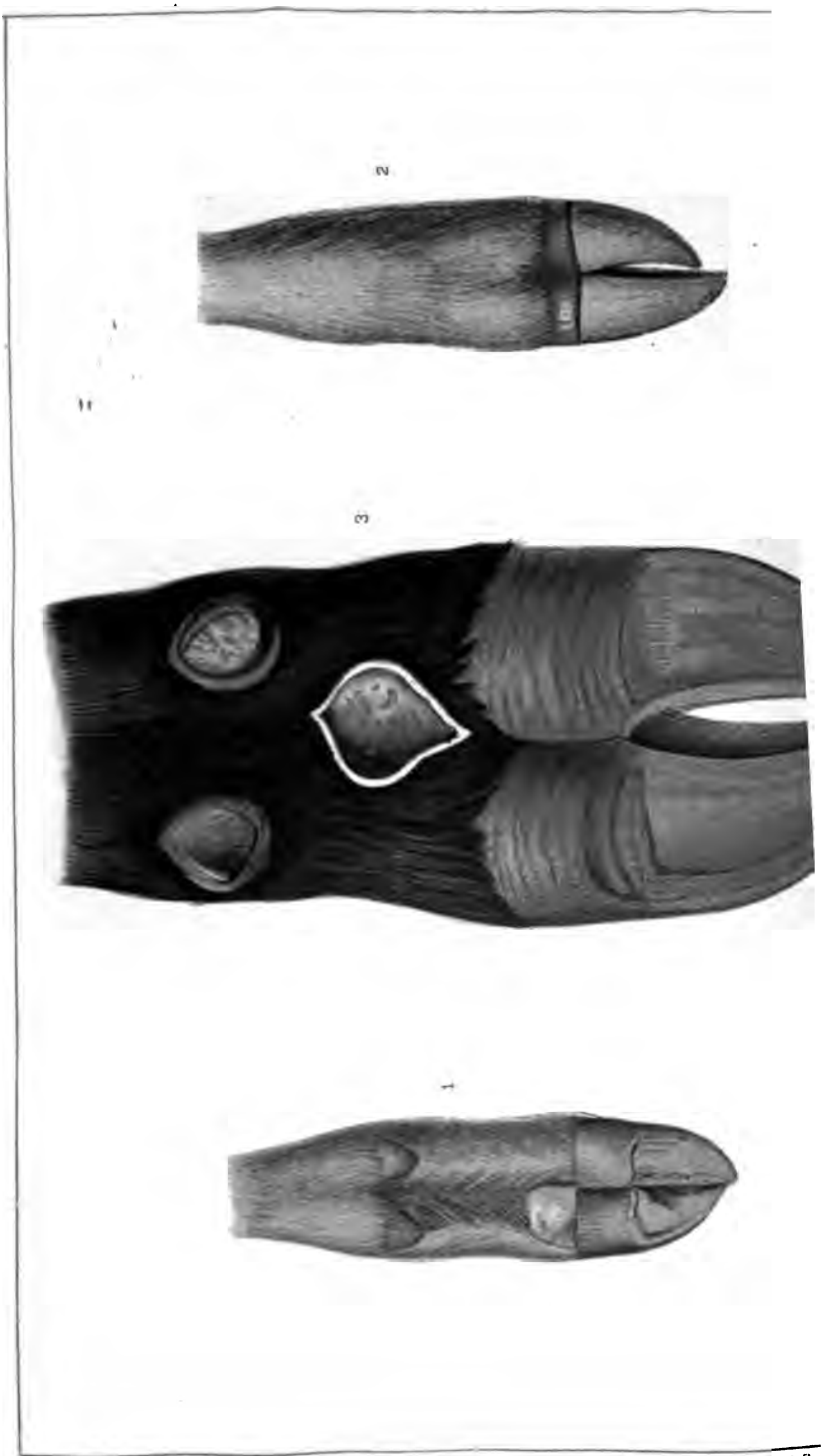
The substance known as ergot is one of the stages in the life history of a fungus which has been named *Claviceps purpurea*. The term ergot was applied to it by the French from its fancied resemblance to the spur of a cock. The place which this fungus occupies in the plan of nature may be understood from the following table, which is taken principally from the classification proposed by Sachs:

	Group.	Class.		Order.	Family.	Genus.
Vegetable Kingdom.	Thallophytes.	Protophyta.	Containing Chlorophyll.	Ascomycetes.	Gymnoascus.	Claviceps.
	Muscineæ.	Zygosporeæ.	Without Chlorophyll.	Aecidiomycetes.	Discomycetes.	Cordyceps.
	Vascular Cryptogams.	Oosporeæ.		Basidiomycetes.	Ersipheæ.	Byssothecium.
	Phanerogams.	Carposporeæ.			Tuberaceæ.	Fumago.
					Pyrenomycetes.	Pleospora.
					Lichens.	Sphaerella.
						Laboulbenia.

The growth of the claviceps begins by the germination of conidia or spores of this fungus, which have been carried by currents of air or other means to the flowers of the grasses favorable for its development. These conidia or spores, as the case may be, germinate in contact with the external surface of the ovary while this is still in an early stage of its growth, and form a mycelium which penetrates the walls of the ovary, and, as a rule, respects only the summit. It thus by degrees substitutes itself in place of the tissue of the ovary, and, consequently, preserves to a considerable extent the form of this organ. It bears on its summit the stigma, while its external coat is traversed by deep grooves and irregular cavities. (In Plate VIII, Fig. 1, is seen the normal ovary of the rye plant; Fig. 2 shows the same invaded by the claviceps.)

In this stage of its existence it has been called the sphacelia. As it develops it takes entire possession of the ovary, obliterating its cavity, and preventing the development of the ovule. The ovule may be either entirely absent or it may be present in an imperfect form, but does not develop into a seed. The mycelium produces at the surface of the ovary a large number of oval corpuscles, which are called conidia, and which falling upon other flowers may germinate and again produce the mycelium or sphacelia form of the fungus. (Pl. VIII, Fig. 3, which is a cross-section of the ovary, now called sphacelia, shows these conidia at its borders.)





Marx ... Nature — T Sinclair & So

FOOT AND MOUTH DISEASE (WALLEY)

Plate X

1

3

2

FOOT AND MOUTH DISEASE (WALLEY)

The sphacelia, however, is not the ergot form of the fungus. At the base of this is produced a hard substance with a black or dark violet surface, and white or grayish within, which is the true ergot or sclerotium stage of the claviceps fungus. In the earliest period of the development of the sclerotium this is entirely covered by the sphacelia, but it gradually increases in size and pushes the sphacelia before it until the latter is raised entirely beyond the floral glumes, and is supported on its summit (Pl. VIII, Figs. 4, 5, 6). The sclerotium, or ergot, continues to increase in size and length, and the deformed ovary or sphacelia adheres to it for a long time, and may even be found in a considerable proportion of the specimens as seen in hay or mature grain after curing. In these the form of the stigma can be readily made out in most cases by the use of a low power lens.

Ergot is not therefore a diseased seed; on the contrary, it develops entirely below the ovary and prevents the formation of the seed. It is entirely a fungus growth, and is the resting stage of the organism. It contains little or no starch, and its microscopical structure is that of the sclerotic mycelia. The sclerotium is looked upon as a hard compact mass of imperfectly developed mycelia. It appears to be about a month from the time the fungus invades the ovary until the ergot is fully formed.

The ergot is the dormant form of the fungus, and remains in this condition until autumn, or usually until the next spring. If at this time it is in contact with the damp ground it germinates and stromata grow from its surface (Pl. VIII, Fig. 7). These consist of a long stalk and a globular head, and become perfect fruiting fungi. In the head a large number of flask-shaped perithecia are formed (see Pl. VIII, Fig. 8), which are filled from the bottom with a number of asci (Pl. VIII, Fig. 9), each of which contains several slender filiform spores (Pl. VIII, Fig. 10).

When the spores reach the young flowers of rye, red top or other nearly allied grasses, they germinate and form a mycelium which invades the wall of the ovary and again produces a sphacelia. With this the cycle of development of the fungus is completed and we probably have its entire life history. The meteorological conditions most favorable for the production of ergot are not well known. It has been asserted that it only appears in large quantities in rainy seasons, but others believe that moisture has little or no influence on its development. It is also uncertain whether more than one species of claviceps is concerned in the production of ergot in the different varieties of grasses. The ergot of the red-top hay in Missouri and Illinois produced identical effects with that in the wild rye of Kansas, and it would therefore appear that the physiological effects are substantially the same even though the species growing upon these two plants may be different.

The grains of ergot of rye are from half an inch to over an inch in length, and from one-fifteenth to one-sixth of an inch in diameter; they are nearly cylindrical, sometimes slightly ribbed and furrowed, and often have irregular fissures; they are curved, and taper toward the ends. The color of the surface varies from dark violet to blue black or black; the interior is white, often tinted with violet. The ergot of wild rye, blue grass, and red top has the same general appearance, but the grains are smaller. In red top many of the grains are so small that they are only recognized with difficulty by the unaided eye. Sometimes the taste is pronounced and disagreeable; but the ergot in the wild rye of Kansas, where the outbreaks of disease occurred, was almost or entirely without taste, and certainly was in no sense disagreeable when masticated.

Chemical composition.—Ergot is a very complex material when considered chemically, and although it has been studied by many competent chemists, there is yet much doubt as to the nature of a number of the substances which have been found in it. About 35 per cent. of its weight consists of a thick, fluid, fixed oil, which is now believed to be without medical properties. Two non-crystallizable alkaloids have been described and called, respectively, *ecbolina* and *ergotina*; and one crystallizable which has been designated as *ergotinine*.

Sclerotic, *ergotic*, and *fuscosclerotinic* acids have been isolated. There is also a question of a peculiar ammoniacal base variously stated to be *methylamine*, *trimethylamine*, and *propylamia*. A mucilaginous substance called *scleromucin* and several other products of doubtful nature have been recognized. It has not yet been demonstrated which of these bodies constitutes the active principle of the drug, or whether the physiological effect may not be due to a number acting together.

The one point on which most of those who have studied ergot have agreed is that water extracts the medical properties, and this seems to be about the extent of our reliable information in regard to this department of the subject.

The action of ergot on the animal body.—The action of this poison in large doses is very clearly given in the following extract from Dr. H. C. Wood's Treatise on Therapeutics, Materia Medica and Toxicology:

According to Diez [quoted by Stille], the principal effects of poisonous doses of ergot are in the lower animals profuse salivation, vomiting, dilatation of the pupils, hurried breathing, frequent pulse, cries, trembling, staggering, paraplegia, sometimes diarrhea, sometimes constipation, prostration, urgent thirst, convulsions,* and death. Mr. Samuel A. Wright, in a series of experiments (*Edinburgh Med. and Surg. Journ.*, Oct., 1839, vol. lii), noted, when the medicine was given by the mouth, symptoms similar to those just spoken of; the paralysis was much more marked than the spasms. Late in the poisoning, the heart's action became irregular and intermittent, and the pulsations, which had been rapid, grew slow and feeble. In some cases the special senses seemed to be destroyed, and coldness of the surface was a very prominent symptom. Mr. Wright also injected a strong infusion of the drug directly into the torrent of the circulation. Death was in some cases produced in nine minutes, the symptoms being immediate dilatation of the pupils, great increase in the rate of the cardiac pulsations, paralysis, and convulsions. When the fatal result was not brought about in so short a space, great anæsthesia of the surface was noted a considerable time before death; coldness of the surface and paralysis of the special senses were also present in some cases. In Dr. Kersch's experiments (*Betz's Memor.*, vol. xviii), the concentrated infusion was injected into the jugular vein; the coldness of the surface was especially noted, and also great muscular rigidity. Upon rabits, according to the researches of Wright, ergot acts very feebly. In birds, as represented by chickens, turkeys, and pigeons, it causes symptoms analogous to those produced in mammals, as is testified by Tessier and by Gross, both quoted by Stille, and by Bonjean (*Traité de l'Ergot de Seigle*, Paris, 1845.)

The above summary of the general symptoms caused by poisonous doses of ergot shows that the phenomena are mainly paralytic in their nature; but, although an enormous amount has been written about the drug, we have very little knowledge as to the immediate causes of the paralysis. Since both Wright (*loc. cit.*, pp. 320, 321) and Köhler have found that the voluntary muscles are not affected by ergot, it would seem that the nervous system must bear the brunt of the poison. Eugene Handelin is said to have shown that the peripheral nerves are not affected, and the experiments of Köhler have confirmed this so far as concerns the motor nerves and the watery extract of ergot. He found, however, that those portions of the drug not soluble in water appeared to increase the excitability of the peripheral efferent nerves, and that upon the peripheral sensory nerves both portions of the ergot acted as a feeble depressant. On the whole, it is probable that the chief action of the drug is upon the nerve centers.

The following experiments of Tessier also indicate the active nature of the ergot poison (*Memoire sur les effets du seigle ergoté. Hist. Soc. Roy. de Med.*, 1777, 1778, Paris 1780, vol. ii, pp. 587–615):

These experiments were instituted with hygienic precautions upon a

* Pereira states that convulsions were not present in the experiments of Diez.

number of animals. Of two ducks fed upon ergot, one, the female, died in nine or ten days. It had consumed one ounce and three drachms of ergot. There was a large violet spot on the beak, the covering epidermis was raised up by a collection of dark, fetid blood. The male died in fourteen days with the beak similarly affected; there was also drooping of one wing which showed two regions of inflammation, one in the fold and the other on the first phalanx. It had consumed 2 ounces and 6 drachms of ergot. A turkey was fed 8 ounces 4½ drachms of ergot within twenty-two days. The autopsy revealed inflammation about the beak, but none of the feet and wings. A pig six weeks old died at the end of twenty-three days after receiving 1 pound and 12 ounces of ergot. The autopsy revealed swelling of the four feet especially at articulations, which were a reddish violet color. The ears were livid, there was gangrene of one side of the head, and various internal inflammatory lesions. The articulations of the feet with the legs being uncovered there was seen, particularly with the posterior limbs, a thick, black, and fetid liquid. The animal previous to death had been able to support itself better on its fore than on its hind limbs. A six-months' old pig died after being fed during sixty-nine days upon a total of 22 pounds and 6 ounces of ergot. The autopsy revealed various internal inflammatory lesions, several violet spots on front and hind legs, the end of the tail dark violet, and ears livid. The two first phalanges of the right anterior foot were gangrenous and dry, especially near the articulations. The bones themselves were tinted brown. The same parts of the left foot were gangrenous but not so far advanced, as the bones were not altered. Upon each calcaneum there was a livid spot, larger on one than on the other. During life there was on the twentieth day a purulent discharge from two cavities in the articulation of the right foot; these were soon covered with a crust. The limb remained cold. On the forty-second day the corresponding joint of the left anterior leg developed a tumor which by the fifty-eighth day became an open sore. Both legs were cold and swollen, dry, insensible, and portions of the muscles became detached. The animal was no longer able to walk.

Salerne, cited by Read, gave to a small male pig barley mixed with half its weight of ergot. At the end of fifteen days the legs became red, secreted a yellowish and fetid humor, the skin of the back and beneath the abdomen became black in color. This food was continued for fifteen days and then replaced by some free from ergot. The animal died four days later; there was no gangrene of the feet. Read fed a pig three months old for fifteen days with ergoted wheat mixed with bran. Gangrene seized the left ear on the seventeenth day and it dropped off. The pig died two days later with convulsions. A gangrenous spot was found on the liver. (A. Tardy. *De l'Ergotism*, Paris, 1858.)

Fleming, in his Manual of Veterinary Sanitary Science and Police, (Vol. I, p. 65), says: "The ergot on rye, wheat, &c., has also given rise to extensive disease in man and animals, including birds, marked by convulsions, paralysis, dry gangrene of the limbs, loss of hair and horn, and other strange phenomena."

M. Tabourin, in his *Nouveau Traité de Matière Médicale de Thérapeutique et de Pharmacie Vétérinaires*, Paris, 1866, gives the following description of the action of ergot (pp. 448 to 450):

The effects of ergot of rye should be divided into medicinal and toxic.

Medicinal effects.—The action that ergot of rye exercises on the natural surfaces and on the denuded tissues has been very little studied with animals, but appears to be slightly irritating; with man it has been noticed that the aqueous extract arrests

capillary hemorrhages with considerable rapidity, and that it has a manifestly astringent action on denuded tissues. In the digestive tube the effects are but little marked when the medicine is given in small doses; it is only when the quantities ingested are considerable that vomiting occurs with carnivora and a serious irritation of the intestines with all animals. In regard to the dynamic or general effects produced by the ergot of rye in medicinal doses, when its active principles have been absorbed, they are almost unnoticeable with healthy animals and have been only very imperfectly studied up to this time. It follows, however, from the trials undertaken by various authors on the greater part of the domestic animals, that this medicine produces with them as with man two effects somewhat opposed to each other: a very pronounced sedative action on the circulatory center, and an energetic stimulation of the nervous centers and particularly of the posterior portion of the spinal cord. We will return to these two culminating effects of ergot of rye in connection with the toxic action that it has on the organism which we are now about to study.

Toxic effects.—The poisoning of animals by ergot of rye is called ergotism. It may occur at the end of a longer or shorter time, according to various circumstances and particularly according as the ergot is given alone or mixed with the food. In the former case, it occurs after a few days with birds, and after weeks or even months with mammals, according to the size of the doses and the time between them. In the second case it is much slower still, and when its existence is manifested by apparent phenomena the destruction of the organism is already consummated and there is no means of providing a remedy for it. This is a remarkable example of chronic or slow poisoning.

The characteristic signs of ergotism are of two varieties. One of these is due to the narcotico-acrid and exciting action that the ergot exercises on the nerve centers; the other is due to the sedative action that it produces on the heart. When the former predominates, as has been observed with certain epidemics with the human species, the ergotism is called convulsive; when, on the contrary, the second is more pronounced the ergotism is called gangrenous. It is difficult to establish this distinction with animals where the signs of the two varieties are mixed in nearly equal proportion as we shall demonstrate.

1. *Solipeds.*—Of all the domestic animals, the solipeds are the least exposed to poisoning by ergot of rye, because oats, the grain they receive most often, is rarely affected with this alteration. Only two authors, MM. Hertwig and Parola, have made experiments on solipeds with ergot of rye. The former administered three and one-half kilograms (7.7 pounds) of this substance to a horse in the space of 24 days; he observed some nervous phenomena and a great depression of the circulation, but no appearance of gangrene. The latter gave ergot of rye to a mule, affected with chronic coryza, for six days in the dose of one to two ounces a day. There was slowing of the circulation, decreased temperature of the body, difficulty of respiration, loss of appetite and strength, general depression, muscular trembling, slight swelling of the knees toward the end, &c. The subject was destroyed. The dischage from the nose had disappeared.

2. *Large ruminants.*—Poisoning of large ruminants by ergot is more common than that of solipeds because these animals receive quite often, as a supplementary ration, the rejected grains coming from the thrasher or from screening, which always contain more or less ergot of rye and of other grains. With the large ruminants the convulsive phenomena are not seen or are not very apparent; but the depressive effects on the circulatory system are, on the contrary, very marked. Besides, the health is maintained without serious disturbance during weeks and even months if the ergot is taken with the food. Only the extremities lose little by little their natural warmth, as is noticed with the ears, the tail, the lower part of the limbs, &c. The digital region, and sometimes even the metacarpal and metatarsal regions, as M. Decoste has observed, are smitten with dry gangrene. In this case, the parts lose their warmth, their sensibility, become hardened and mummified, and soon separate without pain from the parts which have still remained living.

3. *Small ruminants.*—It is known that the sheep may, like other animals, feel the noxious influence of ergot; but science is wanting in precise documents concerning this ruminant and the goat.

4. *Pigs.*—It follows from some experiments made on these animals by Tessier, that ergot of rye poisons them after a greater or less time according to their force of resistance. There is seen in the first place vertigo, unsteadiness in standing, a tottering walk, moaning, swelling of the eyes, &c.; then the ears, the tail, the lower part of the limbs, lose their warmth and vitality; soon appear livid spots, which afterward become black and gangrenous, and are the beginning point for the separation of the mortified from the living parts.

5. *Dogs.*—M. Dieu has given ergot of rye to dogs in the dose of 15 grams (half an ounce) a day. The animals were soon taken with nausea, bloody diarrhea, a nasal discharge also colored with blood, depression, weakness, and soon drop into a fright-

ful marasmus. The experiments not having been pressed to the end, the phenomena of dry gangrene could not be observed.

6. *Fowls.*—These little animals are most exposed to the poisoning under consideration, because they often receive for nourishment the residue from cleaning grain which always contains more or less ergot. The first signs of this poisoning are loss of liveliness, indifference to surroundings, and great dullness; then there is vertigo, drooping of the wings, &c.; finally appear more characteristic signs—a bloody discharge from the nostrils is seen; the crest becomes black, shrunken, and mummified; the beak dries and is detached; the same course is soon followed by the tongue; the feathers lose their luster and fall out. Death results soon after these symptoms are seen.

To recapitulate, the most ordinary signs of ergotism with the various animals are as follows: Dulness, fixed expression, vertigo, dilated pupils, intoxication, coma; in the beginning muscular tremblings, then convulsive shocks, tetanic attacks, particularly in the posterior members which afterward become weak and paralyzed, unsteady position while standing, slow and difficult walk, &c.; general weakness, progressive emaciation; pulse slow and weak, skin cold; hair dull, limbs, ears, horns, and tail lose their natural warmth; sero-mucous and sometimes bloody discharge from the nostrils, cold swelling of the limbs; black spots, livid patches, gangrenous sores; dry gangrene of the crest, of the beak and of the tongue of birds, and of the ears, the tail, the phalanges, the limbs, which become detached little by little and piece by piece from the trunk without inflammation or pain, &c.

Lesions.—The digestive tube is more or less intensely irritated, the viscera are flabby and softened, the muscles semi-gelatinous, the blood fluid, violet colored, the interior of the vessels red as in putrid diseases &c.

M. Verheyen, in his article on ergotism in the *Nouveau Dictionnaire pratique de Médicine, de Chirurgie et d'Hygiène Vétérinaires*, gives the following account of the effects of this poison:

Symptomatology.—In spite of the numerous experimental studies of which the ergot of rye has been the object, its effects on the organism are far from being sufficiently understood to enable us to write in a complete and connected manner the part of the medical history of ergotism relating to the symptomatology and pathological anatomy. The mode of action of ergot on the economy is only presented so far in a fragmentary state; the acquired knowledge does not permit the tracing of a physiological chart of all the phenomena produced by this agent. A large number of experimenters, particularly among the modern ones, have only produced an acute intoxication, of rapid progress, which leaves in obscurity the evolution, the graduation, and the succession of the morbid phenomena; in a word the progress of natural ergotism resulting from the introduction into the economy of small but long continued doses of the toxic substance. History mentions destructive epidemics, and others which have been relatively mild; this difference can only be due to predisposition and to the abundance of ergot. Rye is rich in it in the calamitous years; the high price of cereals, and of all kinds of provisions, prevents the poorer classes from procuring sufficiently nutritious food. There, consequently, follows a constitutional debility and anemia, which singularly favors gangrenous and convulsive disorders. The observation, so precise, of M. Decoste, as regards the hygienic diet to which the cow, which was the subject of it, had been submitted, the conditions under which the epizoötic of the State of New York appeared, proves that misery constitutes a predisposing cause not less energetic for animals than for man. The experimenters have not taken into account these constitutional modifications which increase the susceptibility to the poisonous agent, and give to ergotism a new symptomatic expression. Here, it appears to us, is found the key to the numerous contradictions that are noticed when the experiments are compared with each other. To cite only a single example concerning the bovine species, we see that Riemann did not succeed at the end of eight days in provoking the least abnormal phenomenon, and that Wahlin produced no other noticeable symptom than constipation. The authors who have observed cases of ergotism with animals during the course of an epidemic may be correct when they mention the fact very summarily, and limit themselves to a statement that the phenomena were absolutely similar to those presented by man. This identity justifies, to a certain extent, their laconism, and the epidemic conditions explain the differences obtained by experimenting during the epidemic periods and out of these periods. During the epidemics the rule relative to the gangrenous form in the south and the convulsive in the north is applicable to artificial ergotism. A final remark, perfectly justified, and which has been little if at all considered by the experimenters: Tessier, who brought a high order of intelligence to the elucidation of the history of ergotism, asserts that all animals show a very great repugnance to take ergot voluntarily; this is so insurmountable for some individuals that they will die of hunger rather than touch it. Consequently all were far from being assured that the ergot offered was really consumed.

Having made these observations, let us take up the symptomatology of ergotism—they will excuse the incomplete sketch that we trace.

These morbid phenomena are very inconstant during the period of invasion. Sometimes they indicate a lesion of the cerebro-spinal apparatus, at other times the digestive tube is invaded, at still other times the symptoms proceed from the circulatory system. This variability is common with fowls, with pigs, and with carnivora. The predominance of the cerebro-spinal affection manifests itself in various degrees of intensity; it may be arrested after development when the exciting cause, the alimentary use of ergot of rye, has ceased. In the first place, there is vertigo; the animals stumble as if they were intoxicated; they lose their equilibrium, fall on the side, and remain in a state of drowsiness, which is not dissipated even when they arise. The hair and feathers lose their luster; the temperature of the skin is lowered; there is anæsthesia, the insensibility following a condition of hyperæsthesia; this alternation affects also the sight and the hearing (Wright). It is unmistakable in the canine species; the pupils are constantly dilated. The symptoms of narcotism that we have just enumerated persist or are interrupted by convulsive phenomena, sometimes of the limbs only, and sometimes of the whole body. The general convulsions are characterized by tetanic epileptic attacks usually followed by temporary paralysis of the posterior parts. The suffering is sometimes so intense that it is manifested by plaintive cries and contortions. The nervous attack over, the animal falls again into a condition of apathy or drowsiness. If the spasm is limited to the limbs, there remains after the attack a contraction which persists for a certain length of time.

These phenomena which characterize spasmodic ergotism have an indefinite duration. Death may occur after a few hours or a few days as a result of a paroxysm, or the disease may be more prolonged and take a chronic form. The nutrition suffers; the animals become thin in spite of the appetite, which, however, is irregular, and finally a convulsion at last destroys them in an advanced condition of marasmus. The circulation is abnormal, the pulse is slow, accelerated but afterwards retarded; the arterial and cardiac contractions are spasmodic.

The participation of the digestive tube, which may be either the principal or the accessory cause of the cerebro-spinal affection, is announced by nausea, pharyngial spasms, vomiting, diarrhea, sometimes followed by an insatiable hunger. If this is satisfied the food does not alleviate the hunger, for it causes convulsions. In the south all these symptoms may be preceded by gangrenous accidents; the latter may also precede when the circulatory lesion is the first to occur. With the gallinaceans the crest becomes cold, takes a violet or black color, shrivels, and dries; these phenomena are also quite constant in the north, but the dessication of the beak, sometimes of the feet, constitutes an alteration exclusive to the south; gangrenous patches also cover the abdominal walls (Millet). In gangrenous ergotism of the palmipeds, besides the beak, there is sometimes seen mortification of the point of the tongue (Tessier), and of the interdigital membrane which is discolored and becomes dry and brittle; then the digits are lost (Decoste). With mammals the gangrene attacks the lower part of one or several limbs, the ears or the tail; these parts become red as if they were the seat of an erysipelatous inflammation; the color changes to violet, to blue, or to black; they become mummified and detached when the convulsive paroxysm has not destroyed life before the completion of the work of elimination. While this is occurring the loss of flesh progresses and marasmus comes on, then, finally, a convulsive movement which destroys the patient. The mummification also attacks isolated muscles and in very exceptional cases the dry form of gangrene is associated with the humid form (Tessier). The pulse remains small, feeble, slow, or indeed it becomes accelerated, febrile, and precipitates marasmus.

Sheep which are subject to convulsive ergotism, are probably also subject to the gangrenous form. We have abstained from considering it in the symptomatology because we have not met with documents which authorize us to generalize the symptoms and to extend them to the ovine species.

The gangrenous form is the only one which has been observed with the bovine species; it remains local and is not complicated with the greater part of the general symptoms which may precede it with the other species of the domestic animals that have just been referred to. The appetite is preserved, the muzzle remains moist, and the expression of the eye is not changed. These signs of health often remain until the fatal termination of the disease. The circulatory lesion seems then to be alone in play; it is localized in the digital region of the posterior limbs (Randall), or extends to the metacarpal and metatarsal regions of the limbs of one side (Decoste). A slight swelling of these parts announces the beginning. The hair becomes dull, the skin is dried, hardened, and mummified as well as the parts immediately beneath it. The appetite is preserved, but the animals become thin; a few individuals take flesh after the loss of the gangrenous limbs and may be prepared for the butcher. Death in a condition of marasmus is the most common result. When the affection takes a relatively benign form the gangrene does not destroy the part; the digital region loses its elasticity, the points of the toes are elevated, grow to an un-

usual length, and the weight is supported on the back of the fetlock. In this situation the animals pass a miserable existence until the owner, from pity, sends them to the butcher (Randall). The more benign form seems to us to have a resemblance to convulsive ergotism; the position of the posterior limbs has perhaps for its origin a contraction of the extensors.

In the records of epidemics of ergotism there are found but few references to the disease in the horse, and these are of no use in tracing the symptomatology. We are then reduced to a recapitulation of experiments to the number of two, one made by Hertwig and the other by Parola.

Hertwig administered to a horse within twenty-four days 3,552 grams [about 7 pounds] of ergot of rye. The phenomena observed were slight colics, loss of appetite, which disappeared within a few hours, drowsiness, which also soon passed away, dilation of the pupils, slight spasmodic contractions of the muscles of the skin and diminished temperature of the surface of the body The pulsations of the arteries were retarded from 40 to 28 to the minute. The day following the administration of the last dose all abnormal phenomena had disappeared.

Parola experimented on a vigorous and lively mule affected with a nasal discharge. During six days he gave it, in addition to its ordinary ration, ergot of rye in progressive doses of from 20 to 64 grams [¾ to 2 ounces] a day. The first day, the pulse was from 56 to 58, with lowering of the external temperature. The second day, pulse 58, respiration difficult, tearful eyes, loss of appetite, dullness, beating of heart insensible. The third day, coldness of the skin, general tremors, difficult respiration, spasmodic trouble of the cardiac and arterial pulsations, absence of appetite, apathy, dullness, suppression of the nasal discharge, which returned after the use of irritating injections. From the fourth to the seventh day, development of these symptoms, unsteady and difficult walk, trembling, inclined to lie, painful swelling of the knees, the nasal discharge definitely arrested. After having taken in all 284 grams [0.6 pounds] of ergot, the mule, which had continually lost in flesh and liveliness, became insensible and was destroyed.

It may be concluded from these facts that the horse escapes the pernicious effects of ergot no more than other animals, and that, placed under favorable conditions, one of the two forms of the disease may be clearly manifested, as the result of long and continued use. Ergot is also a poison for insects; in Poland they kill flies by giving as a bait powder of ergot mixed with honey. Leeches, plunged into an infusion of ergot, perish instantly (Lorinser).

Anatomical characters.—Studied for centuries, ergotism presents, in regard to its pathological anatomy, lamentable deficiencies as well with mankind as with animals. Considering the variation of symptoms it is useless to insist that the anatomical lesions cannot in all cases be the same. Those which we are about to enumerate all belong to either artificial or experimental ergotism.

The *rigor mortis* is never excessive; the flabby muscles are softened, the bones engorged with blood, particularly near the articulations. The venous system is distended by a black, pitchy, semi-fluid blood; the arteries, sometimes empty, contain in other circumstances a red fluid blood. In the thoracic cavity the lungs are found hepatized in the posterior portion; the heart flabby, small or voluminous, contains fibrous coagula and a black, viscid, semi-fluid blood; in the left side of the heart, which is often empty, there is nothing found but fibrinous concretions. The mucous membrane of the small intestine is pale, yellowish, infiltrated, and softened, sometimes covered with red striæ or black points. These black points are compounds of fat and pigment (T. O. Heusinger). The mucous membrane of the large intestine shows hyperæmia, which is far from being constant. The proventriculus of the gallinaceans has a gray or a wine-red appearance; its mucous membrane is ulcerated or covered with granulations; the gizzard is black (Millet). Do not the granulations depend upon the ulceration of the pepsine glands? The cerebral envelopes, principally at the base, are congested, engorged with a black blood resembling that found in the veins; a section of the brain shows sometimes a very apparent punctation; in other cases, much more common, it is anæmic. Analagous changes are met with in the spinal cord.

The local disorders of gangrenous ergotism are those of dry gangrene (see *Gangrene*).

Physiological action.—The symptoms of gangrenous or convulsive ergotism, as a whole, indicate incontestably that the nervous system fills the principal rôle. The phenomena observed by Hoppe when he placed ergotine in contact with the isolated organs of the frog or the rabbit would remove all doubt if any could exist. Ergotine causes a marked stimulation of the heart, followed by a weakening and a retardation of its movements; the intestine contracts, but the contraction is not renewed after a second application; the blood vessels dilate; soon follows a contraction with congestion of the *vasa vasorum* which swell and cause the walls of the veins and arteries to become rigid; the sensitive nerves are partially paralyzed; later their sensibility is increased; a general intoxication congests the brain and spinal cord. This last effect

is not constant; the autopsies show that though the envelopes of the cerebro-spinal axis are always congested, wholly or in part, the nervous centers themselves are quite often anæmic.

It follows from these results which are conformable to what is observed in ergotism that the primitive phenomena depend upon a sedation of the sensory nervous system, and this anæsthesia is succeeded by a hyperæsthesia and a retardation of the circulation. The exaltation of the sensibility has not always the same seat; this circumstance explains the variations of the symptoms and the predominant lesions of a functional apparatus. In all cases the hyperæsthesia excites reflex action, sometimes in the intestinal tube (colic, vomiting, and diarrhea); at other times in the voluntary muscles (contractions and convulsions); at still other times in the involuntary muscles of the vessels (gangrene). These reflex actions may be successive, simultaneous, or they are developed separately and remain separated during the whole course of the disease. With man, who can give an account of his subjective sensations, intense pain precedes the contraction; then follows, according to the intensity of the disease, convulsions varying from trembling to epileptic attacks. The over stimulation leads to exhaustion, which brings a calm in the sensitive system. Intolerable pains, which are more localized, also precede the dry gangrene; the patient feels in the part which becomes the seat of it a cold sensation; later, this is recognized by the thermometer and to the patient it seems glacial; the sensation is lost when the gangrenous effect is accomplished. The dilatation of the vessels, followed by a narrowing of their channels are phenomena which are connected with primitive anæsthesia, a secondary hyperæthesia, and with reflex action, which affect the vaso-motor nerves. The rigidity and congestion of the vascular tubes, the weakening of the contraction of the heart, retard the circulation in the extremities, favor the stagnation of the blood, and consequently necrosis, even if the reflex phenomena are not sufficiently intense to obliterate the channel of the afferent vessel and produce mortification by anæmia. What is produced in an intense manner at one or several extremities is repeated at all the periphery in gangrenous and convulsive ergotism; the lowering of the temperature has no other cause than the retardation of the circulation and the reflex muscular spasm. The cerebral phenomena are probably only secondary and are due to the congestion of the brain and its envelopes; the anæmia of this organ would also account for them. It is a law that local congestions go side by side with local anæmia; when ergotism becomes chronic, the anæmia is generalized, a common result in all diseases which are of long duration. The absence of exudations removes all idea of inflammation, and if hepatization of the posterior lobes of the lungs has been found, particularly with the gallinaceans, this lesion is neither constant nor general.

The medium dose of this agent for medicinal purposes is given by Tabourin (*Nouveau Traité de Nat. Med., etc., II, p.* 447) as follows: Cattle and horses, one-half to one ounce (16 to 32 grams); goats, sheep, and pigs, one to two drachms (4 to 8 grams); dogs and cats, one-half to one drachm (2 to 4 grams). Finley Dun says: As a parturient or styptic, for the mare or cow, one-half to one ounce; for sheep, swine, and bitches, about one drachm (Vet. Medicine, p. 212).

HISTORY OF ERGOTISM.

Wood states that epidemics of ergotism or chronic ergotic poisoning have been recorded from time to time since the days of Galen [130 to 200, A. D.] and of Cæsar [B. C., 100 to 44]. (Therap. Mat. Med. and Tox., 4th ed., p. 565.) There is much reason for doubt, however, in regard to the diagnosis of cases occurring before the tenth century.

Verheyen says that, "From the ninth to the thirteenth centuries several grave epidemics appeared in France. The first chroniclers who made mention of them, faithful to their traditional habit, confounded them under the generic denomination of *plague* (*peste*). In the tenth century these epidemics received a special name; they were called *ignis sacer, arsura, claudes seu pestis igniaria.* In the twelfth century the nomenclature was increased with the terms *ignis sancti Antonii, sancti Martialis, Beatæ Virginis, ignis invisibilis, seu infernalis.* All these expressions were used to designate one and the same affection, which was no other than ergotism.

The learned historian of the epidemics of *feu sacré* of the Middle Ages, Professor Fuchs (*Das heilige Feuer im Mittelalter*, Berlin, 1834), fixes the first invasion in the year 857. This explicit passage of the chronicle leaves no doubt in this regard. *Plaga magna vesicarum turgentium grassatur in populo et detestabili eos putredine consumsit, ita ut membra dissoluta ante mortem deciderunt.* (Pertz, 11, 230.) The epidemic of 590 (Greg. Tur., X, 30) that some authors refer to the *feu sacré*, does not appear to us to

have presented the characters of this. Its course was extraordinarily rapid; it began with a slight headache, a forerunner of death (*ita ut modico quisquis ægrotus capitis dolore, pulsatus, animam funderet*). These morbid characters can no more be considered ergotism than the very vague statement that near Limoges several were consumed by the *feu celeste* with which some were burned in Tourraine (*nonnulli ab hoc igne sunt adusti*). At the same time a very fatal epizootic occurred which did not spare the deer. A great drought had destroyed the herbage; it followed rains and inundations, conditions favorable to the evolution of charbonnous diseases. A fact supporting this view, as well as the opinion of Fuchs, is that rye, which is an Asiatic plant, was only introduced into cultivation during the Middle Ages (Link). Admitting, what is supposed, that Europe is indebted for it to the invasion of the Huns, it is still very necessary to take into account the condition of this part of the world before concluding that at the end of the sixth century the new cereal had become generalized and had entered into the regular agricultural rotation of Gaul.

All the epidemics of *feu sacré* correspond to years which were characterized by a rigorous winter followed by a very rainy summer, causing a deficiency in the harvests, and bringing scarcity and famine. The epidemics began about the month of September or October and terminated in the spring, unless the atmospheric condition of the following year continued to be fatal to the products of the earth. No mention is made of great epidemics of *feu sacré* during years which were characterized by productiveness, but local epidemics are met with which were circumscribed within the limits where the center of ergotism still exists in our days, and which comprises *la Sologne, le Dauphiné, le Lyonnaise, la Lorraine, and l'Artois.*

If we take into account the conditions which concur in the evolution of *feu sacré*, it may be established, *a priori*, that the sanitary state of the domestic animals was not more favorable than that of the human species, and that epizootics should have been more frequent than they are mentioned by the chroniclers. Are indications found in their annals which authorize us to attribute these epizootics to the same source, that is, to the *feu sacré?* This question cannot be solved; more than that, the accounts themselves forbid an hypothesis relative to the form and nature of simultaneous diseases. It is sufficient to cite this passage from the chronicle of St. Bavon, referring to the year 1127: *Plaga divina Franciam affligit, ignis scilicet corpora crucians. Pestilentia maxima facta est animalium.* What was this plague of animals? Formulated in this manner it is impossible to conjecture. If in the presence of such profound obscurities we are permitted to hazard an opinion, we would say that in all probability the food of the animals did not consist of rye in these calamitous years when scarcity and famine were general, and when the cause of *feu sacré* was unknown. Removed from the toxic factor, they did not escape its powerful accessories, and the diseases which decimated the herds must have been other than ergotism.* Perhaps the first epidemic of *feu sacré* which ravaged Portugal in 1189 was an exception, and it may be necessary to attribute the concomitant epizootic to ergotism. It is thus described: *Hujus etiam tempore morbi nunquam, ante, visi ingruebant, ferventissimis intra viscera ardoribus, quibus homines quasi quadam rabie exagitabantur. Exorta etiam fames, frugibus tam vi tempestatis, quam verminibus corruptis, et lues non minus nocens pecori quam hominibus et multorum relictæ vacuæ possessionibus* (C. F. Heusinger, Fuchs).

The uncertainty relative to the form and nature of the epizootics is one of the most common facts in the records of the Middle Age. Thus the beginning of the famous black plague in 1347 was preceded in several countries by epizootics no less fatal. *In primis hæc acerba pestis in brutis animalibus incohavit; scabies et lepræ totaliter apprimebant equos, boves, pecudes, et capras; ita ut pili de dorsi ipsorum depilabantur et cadebant et efficiebantur macri et debiles, et post paucos dies moriebantur. Deinde incipit hæc rabiosa pestis per universum mundum discurrendo in miserabiles homines lethaliter sævire* (Cutteis). This passage evidently refers to a gangrenous affection, which has nothing in common with *feu sacré*, for with the exception of the epidemic of Brittany, which occurred at the beginning of the black plague, no traces of ergotism are found until 1373, when it appeared anew in France (Tessier).

During the whole period of the Middle Age but rare epidemics of *feu sacré* are mentioned in the north of Europe. Heusinger believes that those of the fifteenth and sixteenth centuries, designated by the name of scorbutus, belonged to ergotism. This opinion appears to us to have foundation; in fact the celebrated botanist, Dodonæus, described the epidemic of scorbutus, which occurred in Belgium in 1556, and was characterized by gangrene of various parts of the body. He attributed it to the spoiled grain which was imported from Prussia, and says in another work (*Historia frumentorum, Anto.*, 1569), that bread made from spoiled rye (*seigle altéré*) causes the disease called by the Germans scorbutus. The gangrenous form of this affection, which did not conform exactly to that observed in France and Spain, was replaced in the course of the sixteenth century by the convulsive form. When the epidemics

* The author appears to have overlooked the fact that such a disease might have been produced by ergotized grasses.—D. E. S.

of ergotism of the South and those of the North of Europe are compared a very remarkable fact presents itself; in the South the gangrenous form is the rule: a few of the epidemics were complicated by muscular contractions (*contractures*); in the North, on the contrary, dry gangrene was a rather rare affection. This phenomenon is applicable to animals with which ergotism has been observed during the continuance of an epidemic as well as with those experimented upon. Fowls are the only exception, and with these gangrene of the comb is an almost constant result. Do the properties of ergot of rye differ in the north and in the south? Chemical analyses may, perhaps, inform us; in waiting for these we may admit that the phenomena are not dependent upon the dose. In 1840, after threshing, ergot made up half the harvest of Finland. The epidemic showed itself as acute febrile, convulsive ergotism. Death very often occurred within forty-eight hours (Haartman).

Dating from the seventeenth century observers were more attentive to the phenomena presented by animals during the epidemics of ergotism, but they notice the fact with a briefness which cannot satisfy the science of pathology, because the proper elements are not furnished for retracing the medical history. Brunner, the recorder of the epidemic of 1694, in *le Harz*, limits himself to this phrase: *Novi pecora, armenta, sues, equos, anseres quoque non fuisse a contagione immunia.* In spite of the contagion which he admits, Brunner leaves nothing equivocal in regard to the cause, for he says: *Degeneravit quoque secale et loco granorum alimentariorum protrusit cornicula nigra.* The *quoque* relates to oats which had equally undergone degeneration, the characters of which are not indicated; its meal produced vertigo in the persons who consumed it. It would have been interesting to indicate the effect produced in horses, but the author maintains an absolute silence in regard to this. Though distinguished botanists affirm that the oat is subject to ergot, we must admit that our researches to discover a fact where the injurious properties of ergoted oats have been noticed with animals have remained without success.

In the description of the epidemic in Silesia in 1722, we read that the King of Prussia ordered an exchange for sound rye of that affected with ergot, which, as usual, caused sickness of the horses and hogs (Hecker). Convulsive ergotism reappeared in Silesia and Bohemia in 1736. Antoine Soring, the historian, makes the remark that it is known and demonstrated by experiment that ergoted rye produces disease with fowls and mammals, and that when animals suffer during the epidemics of ergotism it is conclusive of the quantity and violent action of the ergot in the rye.

From 1765 to 1769 ergot was very abundant in Sweden in the rye and barley. The epidemics which followed were attributed by Linnæus to the grain of the *Raphanus raphanistrum*, from which is derived the name Raphania, which in Scandanavia is still given to convulsive ergotism. Wahlin, after having experimentally demonstrated the innocuousness of the seeds of Raphanus, observes that there is no reason for not accusing ergot when, in the course of an epidemic, domestic animals such as fowls and hogs present similar symptoms to what are seen in man. This passage tends to prove not only that the domestic animals contract convulsive ergotism, but also that the ergot of barley is as dangerous as that of rye. This is, besides, confirmed by Retzius when he asserts that beer brewed with ergoted barley becomes a cause of convulsive ergotism for those who consume it. In Hesse, it has been often observed, notably in 1770, that the heads of barley contained as many, if not more, long, black grains as the rye. In our times (1856) this same remark has been made by T. O. Heusinger.

Traube, who left a much esteemed description of the epidemic of 1770, which was very extensive in Hanover, says that so far as he was able to observe the facts for himself, he saw in the circle which he traversed a single pig attacked with convulsive ergotism. Horses eating the ergoted bread were not incommoded; bovine animals consumed the flour with repugnance, but also without inconvenience. Dogs and sheep were not affected, with the exception of the little village of Lohe, where 7 sheep succumbed after presenting the phenomena of the convulsive disease. These animals had pastured on the rye fields after the harvest, which was made in a very dry time, when an abundance was lost by shelling. Traube did not discover a single case of abortion which Soring and others thought they observed with hogs. One fact impressed him: traveling through the villages which still contained the sufferers, the following spring, he heard general complaints in regard to the small number of the young fowls. But few eggs were produced, and the hens did not sit. Nothing of the kind occurred in the villages which had been exempt from ergotism. Two fowls were sent him which presented the spasmodic symptoms; these birds, placed upon their feet, fell to one side, allowed the head to hang, and agitated the limbs. When they arose of themselves the phalanges were contracted spasmodically; they lived four weeks; no autopsy was made (*Geschichte der Kriebelkrankheit*, 1782, pp. 13 and 15).

It is seen that in these epidemics the convulsive form predominates, while in France the gangrenous form is almost exclusive. The last extensive epidemic from which this country suffered occurred in 1750, and the ravages at this time recalled those of the Middle Age. It commenced in Sologne, its traditional center, and extended

through Landes, Flanders, and Artois. The ergot formed a third of the threshed rye; animals which were fed upon it contracted the same gangrenous accidents as man (Salerne).

Toward the last third of the eighteenth century the epidemics of ergotism were no longer so frequent; the perfection of agriculture may claim a part in this happy result, but the greater part is incontestably due to the generalization of the culture of the potato in the North and of maize in the South. In spite of these alimentary guarantees ergotism was not extinguished. In the present century it was mentioned by Courhaut and Bordot, in 1855; Barrier observed the gangrenous form in the departments of Isère, Loire, Haute-Loire, Ardèche, and Rhone. Ergotism has reappeared in Russia, Finland, Sweden, and some cantons of Germany. In the epidemic described by Wagner (1831) the hogs which ate ergoted rye presented the same symptoms of the disease as the human species, and Helm saw in Pomerania 12 hogs which, a few hours after having consumed a ration of rye mixed with ergot, were taken with vertigo and convulsions. They moaned and uttered anxious cries; the posterior parts were paralyzed, and the animals manifested their sufferings by singular contortions. The last epidemic occurred in 1855; it appeared in Hesse, and concurred with that mentioned in France by Barrier.

A peculiarity worthy of remark was connected with the Hessian epidemic; the younger Heusinger, who recorded it, says that his father, professor at the University of Narbourg, who was charged by the Government to examine the harvests of the year, accomplished his mission before the threshing. In the sheaves of the cereal he found a large quantity of *Bromus secalinus* [common chess or cheat] rich in ergot, though the heads of the rye were exempt from it; and as this ergot presents all the physical characters belonging to that of rye, it becomes certain that this cereal is not always to be blamed as much as has been generally believed. Rye harvested on lands badly cultivated was infested with *Bromus;* when properly cultivated but little was produced. This fact demonstrates the great influence of agricultural progress on the extension of ergotism and its cause. In countries where agriculture is in an advanced condition, as in Belgium, ergotism, either in the gangrenous or convulsive form, is unknown. The observation of Heusinger is not the only one; in two communes of the principality of Waldeck the ergot of chess also caused an epidemic (Rœrig).

This fact is not without interest for the veterinarian, since straw makes up part of the food of the domesticated herbivora, and the plants mixed in the sheaves, with the nature of their productions, merits more attention than is generally bestowed upon it. During the continuance of the epidemic in Hesse, T. O. Heusinger collected information in regard to the diseases which affected domestic animals. He learned that in the commune of Roda, where the most people suffered, and where convulsive ergotism was most violent, the sheep presented symptoms which could be referred to poisoning by ergot with the more reason as these animals were fed with rye straw and received the screenings of the grain. The inhabitants complained of the great mortality among the sheep; the shepherds reported that several had jumped the inclosures of the pastures, that they were then taken with convulsions and turning in a circle had dropped dead as if thunderstricken. Abortions were frequent, as also early parturitions; the greater part of the lambs died.

Doctor Randall reports that in the State of New York a disease appears each winter among the cattle, which begins by a slight swelling of the lower parts of the posterior limbs, with stiffness of the joints. This affection, which has the appearance of being very mild, invariably terminates by dry gangrene of the parts first involved, which freeze after the mortification. In the severe climate of New York the animals winter in the fields, and the farmers attribute the disease to freezing. Randall observes that if this were the real cause a circular line of demarkation would not divide the dead and living parts as regularly as happens in this disease, and, finally, that the external appendages, less protected against the cold than the limbs when lying, should freeze sooner. He adds, and it is the opinion of several other physicians, that the affection is no other than gangrenous ergotism. Indeed the *Poa pratensis* is rich in ergot, and as it does not produce each year an equal quantity, Randall thinks that the cases more or less frequent correspond to the abundance of ergot. (Veterinarian, 1842.)

If, in presence of the facts enumerated, we cannot fail to recognize the existence of gangrenous and convulsive ergotism with animals, we must also admit that these facts are neither so precise nor have the rigorous correlation of cause and effect which is desirable in pathology; they do not even give the elements for a symptomatic table. Randall furnishes in this connection some important information; it agrees with that contained in the interesting observation of Decoste. (Rec., 1848.) These materials joined to the phenomena studied with animals in experiments permit us to trace the symptoms of gangrenous and convulsive ergotism.

Mr. Fleming, in his work entitled Animal Plagues, has compiled a considerable number of references to epidemics and epizootics of ergot-

ism, which, while they contain a large part of the early records relating to this interesting subject, also illustrate the difficulty in deciding at the present time in regard to the real nature of some of the diseases to which allusions are made.

In A. D. 992 there was a long and severe winter and an extremely dry summer, followed by famine. The wheat crops were affected with blight or ergot, and the forage was generally of a bad quality. Soon after there was a widespread and deadly epidemic of ergotism (*feu sacré*) in France.

Ergotism was again prevalent in France in 994. (An. Pl., I, p. 58.)

In 1041 there was most unpropitious weather, accompanied by earthquakes, tempests, and inundations. It snowed heavily during harvest time. In many parts of Europe there were heavy rains throughout the year. Flanders was inundated by the sea, and there were great storms. The consequences of these disturbances were famine and disease in England, Germany, and France. Cattle and men appear to have suffered equally. "The plague of Divine Fire (*ignis divina*, ergotism, or erysipelas) afflicted many, who were saved only through the merits of the Blessed Virgin. And in all that year it was very sad in many and various things, both in tempests and in earth's fruits. And so much cattle perished in this year as no man before remembered, both through various diseases and through bad weather." (An. Pl., I, pp. 60, 61.)

For 1085 Mr. Fleming makes the following record: Epidemic erysipelas (ergotism?) in France, with inundations and famine. "In the year 1085 there was disease in plants, and also in animals, throughout the world." (An. Pl., I, p. 63.)

In 1089–'91, on the Continent, "in these years many men were killed by the *ignis sacer* (ergotism or gangrenous erysipelas), which destroyed their vitals, putrified their flesh, and blackened their limbs like to charcoal. Even if their lives were preserved their extremities were so affected that they were only reserved for a most pitiable existence." This epidemy is mentioned by several ancient chroniclers. Animals suffered as well as the human species. (An. Pl., I, p. 64.)

In 1099 gangrenous erysipelas (ergotism?) in France in the human species. From the severity of the epidemy, we may infer that animals also suffered. There were great inundations in England by the sea and by the rivers, whereby people, cattle, and whole towns were drowned. (An. Pl., I, p. 65.)

In 1127 the "divine plague" (ergotism?) appeared in mankind in France. Prayers to the Virgin Mary healed the afflicted, it is recorded. Great pestilence among animals.

In 1213 gangrenous erysipelas (*feu sacré*) in mankind in France and Spain.

> Neither was the scarcity limited to the fruits of the earth, nor disease to the human species, for birds, cattle, and sheep became sterile, and brought forth no young, and many riding and other horses perished for lack of straw and barley. (An. Pl., 1, p. 71.)

In 1598, after inundations and heavy fogs, there was a general epizoöty among cattle in Germany. In the same year there appeared ergotism in the human species. (An. Pl., I, p. 138.)

In 1694 an eruption of Mount Vesuvius. A supposed epidemy and epizoöty of ergotism. Brunner writes:

> By what unfortunate combination of circumstances, for so many years, the whole of nature seemed to labor under an unhealthy atmosphere remains a secret. Many men, and those most learned, have written on the state of the air, and I have been a spectator of most grievous calamities; for not only did unwonted fevers attack and

kill the human race, and would submit to no remedies, but also the beasts were harrassed by deadly diseases. I know that sheep, cattle, pigs, horses, and geese were not free from the contagion. There was also a lack of corn, not only on account of the inordinate consumption of it by the soldiers, but also from the character of the ground. Some of the corn was so plainly diseased that it was dangerous for man to eat of it. I know also that pease, which formed a great part of the food of the army, were infested and diseased by a small insect, which made a minute hole in them. I never remember seeing such an abundant crop of darnel (tares) mixed with the oats, and which prevented the making of good oat meal, our chief food, for it was needless to attempt to labor on it, it was so bad. All grain disappeared, and in its place small, black, horn-shaped masses became apparent, which were highly injurious to mankind. These were named "St. Martin's corn." A woman was shown to me by a surgeon who suffered from convulsions every eleventh day, solely from eating this corrupt grain, and the same surgeon told me he had amputated a leg mortified from the same cause. (An. Pl., I, pp. 166–167.)

In 1721 the winter was mild, but the spring time cold and damp, and the remainder of the year wet. Locusts in France and the whole of Italy. Epidemic ergotism in Silesia during this and the next year, and scarlatina in man at St. Petersburg, Courland, and Lithuania. So notorious was it that diseased grain produced formidable diseases in the lower animals, that while the epidemic continued in Silesia the King of Prussia issued an edict forbidding the use of rye tainted by the ergot, because it seriously affected horses and pigs. (An. Pl., I, p. 234.)

Another strange phenomenon was the generally laborious parturitions of the domestic animals at this period:

The sheep in many places lambed with great difficulty, so that the shepherds were obliged to use force to deliver them. Among the cattle one hears of nothing particular beyond the fact that the breeding cows and ewes brought forth their young with great difficulty so that force was obliged to be used to assist them. At Strelitz three fine young cows died from this laborious parturition. They strained so violently that all their internal organs were protruded. (An. Pl. I, p. 235.)

In this connection Mr. Fleming gives the following quotation from Hecker:

The uncertainty pertaining to the nature of epizootics of the Middle Ages, leaves us in doubt as to whether some of them might not belong to that class which have a common origin with many of the epidemics of mankind. *The ignis sacer, arsura, claudes seu pestis igniaria, ignis Sancti Antonii, Sancti Martialis, Beatæ Virginis, ignis invisibilis, seu infernalis*, &c., would all seem to be employed to denote the same affection, and which we have reason to believe was ergotism. It is only by chance, as it were, that wide-spread and fatal diseases among the lower animals are mentioned as occurring coinicidently with these obscurely named epidemies, and when we read that the causes of their outbreak were unfavorable weather, which brought about a diseased condition of the crops and pastures we are only partially enlightened as to the nature of the affection.

The scorbutus of the fifteenth and sixteenth centuries has been supposed, with much reason, I think, to have been ergotism, and up to this period it appears to have developed in a gangrenous form. At this time, however, it changed to the convulsive type, which it has chiefly maintained to the present. A curious feature in this disease is shown as it appears in the South and North of Europe. In the South, the gangrenous form is the rule; in the North the convulsive form is particularly marked, and very rarely the dry gangrene; while a few of the epidemies present both characters. The same peculiarity is observable in the phenomena of ergotism in the lower animals during the existence of an epidemy, and it has also been shown to exist by experimentation; the only exception would appear to be in the case of gallinaceous birds, in which gangrene of the crest or comb is the most constant phenomenon. It is not until the seventeenth or eighteenth centuries that we can with certainty find authors describing ergotism in the epizootic form in animals and from that time till now observers have been numerous. (Page 234.)

Convulsive ergotism appeared in mankind in Silesia and Bohemia (1736), and Antoine Soring, the historian of the epidemy, notices that it had been remarked, and the subject had been demonstrated by experiment, that spurred rye produces disease in fowls and mammiferous animals, and that when we know positively that animals are affected

in this way during epidemies of ergotism, we may conclude that the rye is very rich in ergot, and its action very violent. (An. P. I, p. 262.)

In 1754 a very extensive epidemy of ergotism prevailed in France, nearly approaching in its ravages those of the Middle Ages. It began at Sologne, its traditional birthplace, and spread through the Llandes, Flanders, and Artois. The ergot was so abundant that it formed one-third of the rye. The animals fed on it contracted the same gangrenous diseases as afflicted the human species. (An. Pl. I, p. 384.)

The next outbreak referred to is described as follows:

An epidemy of ergotism was also reported as occurring in many northern countries caused by the wheat, rye, and corn having been diseased. It lasted during this and the next year, and animals seem to have suffered. Wagner described it as it appeared in the marshy districts of Saxony, the circle of Schlieben, and on the banks of the Elster: "A light frost destroyed the blossom on the vine and the rye in 1831. Each partially withered blossom of the rye crop, instead of a healthy seed, brought forth a spur of ergot about three-fourths of an inch long. * * * In some houses, where the disease raged most violently, grain was found consisting of two parts of diseased and one of bitter rye, vetch and a variety of other seeds. * * * Pigs ate ergotized rye (*Mutterkorn*), and suffered from its effects. Dogs, however, instinctively avoided it; but when compelled by hunger to eat it, they exhibited symptoms of madness (*Tollwuth*). I believe that such food was partaken of here and there by dogs, and that it assisted in producing madness, as dogs and cats were so affected that no man ever remembers seeing so many mad as during the existence of the ergotism (*Kriebelkrankheit*) among the people. This unhealthy grain may have had something to do with the sickness among the lower animals which prevailed at this time, and which was ascribed to the choleraic influence, though its share must have been small." (An. Pl. II, p. 172.)

Raphania in pigs was witnessed by Dr. Helm:

Twelve pigs of various ages were fed with rye which contained much ergot. A few hours afterwards convulsions set in, with foaming at the mouth; the animals grunted and groaned most piteously; became paralyzed in the hinder extremities, and expressed their agony in the strangest contortions. At first I presumed the disease arose from the bite of a mad dog, but on opening the first animal that died I discovered the nature of the malady by finding in the stomach much ergoted rye. The jaws were so tightly closed that with great difficulty a purge of white hellebore was introduced, and that was followed by a dose of vinegar and buttermilk and repeated douches of very cold water. By these means seven of the animals were saved. The other five died in the course of a few days. (An. Pl. II, p. 197.)

In our own country we have no compilation of the references to animal diseases which may have been made from time to time, and hence it is impossible for me to give a history of ergotism in this country. My attention, however, has been called to the following article in the Farmers' Cabinet, Vol. III (1838–'39), p. 161, which shows not only that the disease has occurred heretofore, but that its cause was recognized:

I have just seen a number of the "Farmer and Gardener" of Baltimore, dated 19th June last, which contains an article on the "Hoof-ail" of cattle, and copied from the *Genesee Farmer*, upon which I will make a few remarks.

The writer of the article, John B. Bowers, dates from Ledyard, and ascribes the loss of the hoofs in three cows to their having been fed for eight or nine days on spear grass (I suppose our green grass, *poa viridis*) affected with ergot. The conjecture is well founded, as you may be assured by referring to the fifth volume of the Memoirs of the "Philadelphia Society for Promoting Agriculture," p. 196, where you will see a paper of mine on the subject, which I think will leave no room to doubt as to the cause of the disease. It is a curious fact that the ergot of rye, if ground into meal with sound rye, when made into bread and eaten produces mortification of the lower extremities in France. (See Memoirs of the same society, volume 3, appendix, p. 5.)

JAMES MEASE.

CHESTNUT STREET, *October* 6, 1838.

Dr. James Mease, the writer of the above, gives the following additional information on the same subject:

In the year 1803, the late Joseph Cooper, of New Jersey, informed me that he had observed the hay made of the natural green grass, or spear-grass (*poa viridis*), growing

on his fine meadows, on Petty's Island, made by banking out the Delaware, to be occasionally affected with a black spear, about one-fourth or half an inch in length, somewhat resembling the ergot in rye, and that cattle eating such hay became affected with a disease in their hoofs, causing them sometimes to drop off. He ascribed the morbid production in the grass to neglect in supplying it with water from the river, by means of sluices, during the dry season. Upon my mentioning the facts soon after to the late William Rush, of Philadelphia, an extensive grazier, he confirmed them from his own observations at Blooming Grove, near Gray's Court, in the State of New York, in the winter succeeding the very dry summer of the year 1793. The hay was the produce of a bog meadow; it is presumed, therefore, that it was made from the same natural grass that grew in the meadows of Joseph Cooper.

Some years after, Mr. W. T. Woodman, of Tredyffrin Township, Chester County, Pennsylyania, communicated to me an account, in the following letter, of a similar disease, and from a like cause, among his father's cattle:

"Having observed the remark in the *Port Folio* for May, 1815, in the review of the third volume of the Memoirs of the Philadelphia Agricultural Society, that, 'as yet, in America we have never heard of any human person falling a victim to the ergot, nor indeed is it satisfactorily ascertained that it has ever been injurious to our animals, I think proper to communicate to you an account of a disease which in 1802 or 1803 prevailed in this neighborhood among milk cows particularly, but which also affected other cattle and horses. You will perceive that it was analogous to the one supposed to be occasioned by ergot.

"For my part I am entirely ignorant of the cause, but still I am unwilling to ascribe it to ergot (with which rye in this neighborhood is more or less affected every year), for this reason, that milk cows, which are never fed with rye by our farmers or butter-makers, exhibited more violent symptoms than oxen or horses.

"The farmers attributed the disease to a peculiar mildew, which sometimes affects the grass on the bottom meadows of a small stream, the basin of which is very extensive, and very luxuriant, and entirely appropriated to meadow land, and suffered to lie under natural grass. No timothy or other grass seeds have ever been sown on it, to my knowledge.

"The cattle affected did not appear to lose their appetite, and while they ate heartily of hay and other food became daily more and more lean, manifesting great uneasiness, occasioned most probably by violent itching. Their hair in many places fell off, or was rubbed off by the animal in striving to scratch itself. After these symptoms had continued for some time, one or both hind feet became sore and the hoofs loose, at which period the animals began to grow better. Others lost their hoofs and part of their legs. Three of my father's cows lost both of their hind feet, and some others in the neighborhood were equally as bad. The legs began by drying and growing smaller from the hoof to half way between the fetlock and the hock, at which point it appeared as if a string of twine were tied very tight round the leg. Above this part the flesh was to all appearance in perfect health; the lower part was hard, black, and offensive. When the lower part became quite dry, and little else than bone, it separated and fell off, after which the animals lived and ate heartily, hobbling along on the remaining stumps. They even began to grow fat. Their health seemed perfect. They would, no doubt, have lived long in this state, and were killed only from motives of compassion.

"One cow belonging to my father, which had lost only one of her hind feet, and that at the first joint above the foot, bore a very strong, vigorous calf, which lived and did well. The cow also afforded as much milk after as before her misfortune, and was pastured on the same grass to which her disease was attributed when in a state of hay.

"I think the disease was never known but one season. The first symptom of it was observable in February, and it reached its crisis about the middle of May. Should this communication lead to any further observations on the nature and cause of the disease I shall be much pleased, and they may be of great service to the agriculturist. Should the disease ever again make its appearance I shall be more particular in my observations.

"I remain, very respectfully,

"WM. T. WOODMAN.

"P. S.—It should be observed, that though we have every year more or less of the ergot, the quantity of it is never considerable. I think there is seldom more than one pint to a hundred bushels of rye.

"Different remedies were tried, but none of them afforded any relief."

"Being desirious to acertain whether the disease of the grass to which Mr. W. referred had grown in meadows that had been deprived of their usual supply of water, I addressed a letter to him in reference to this point, and received the following answer, under date of June 10, 1815:

"Your favor of the 30th ultimo came to hand the 4th instant. Since the receipt of it I have made numerous inquiries, for the purpose of obtaining additional information

respecting the disease (of which I communicated an account), and on the season preceding its prevalence, &c; but I regret to inform you that farmers in general are so deficient in observation, and so entirely out of practice of recording facts, that I have not been able satisfactorily to ascertain whether the season in which the "injurious hay was made" was a dry one or not.

"However, my father informs me that, as nearly as he can recollect, about that period the ditch which conveyed water to his meadow became so filled with mud and accumulations of mud and other matter as to render the supply very imperfect. As a deficiency of water appears to be the cause of the unwholesome qualities of the hay, it is highly probable that the injurious hay was made during the season that water was wanting. But shortly after this time the death of my grandfather in a great measure excluded my father from the benefit of the water. The original plantation being divided into two farms, and that of my father lying farther down the stream, the water of the artificial course is exhausted before it reaches his land. It should, however, be remarked that since that period he mows his grass while it is very young, and before the seeds are touched by the "smutty affection." Indeed, the farmers generally in this neighborhood, since their cattle were affected with the disease, are careful to mow much earlier than they did formerly.

"I am strongly induced to believe that Mr. Cooper ascribes the disease to the proper cause, for I have been correctly informed that a load of the injurious hay was sold to —— Rogers, who at that time kept the Buck Tavern, in second street, whose cow, in consequence of feeding on it, was affected with a disease of a similar nature.

Your friend, &c.,

W. T. WOODMAN"

The disease prevailed to a great extent in Orange County, New York, in the year 1820, and is very well and minutely described by Dr. Arnell. corresponding secretary of the agricultural society of that county, The facts detailed by him leave no doubt of the deaths of numerous cattle in his vicinity being caused by their eating hay made from some grass that was affected with the species of ergot observed in the produce of the meadows before mentioned, for he expressly mentions that the spear grass grew in the meadows in the towns of Wallkill and Blooming Grove, where the disease prevailed, and in a bog meadow soil. Dr. A. remarks that, "the hay was cut in June or beginning of July, immediately before harvest; that only cattle in good condition suffered from eating the diseased hay, the poor and meager escaping." The means of prevention pointed out by Dr. Arnell are similar to that judically recommended by Mr. Woodman, viz., to cut the grass early, before the ergot forms; or, if it be found in the grass, to defer cutting it until late, when experience proves that it may be safely used; for Dr. A. remarks that "the ergot then becomes dry and shriveled, without any of the flour or vegeto-animal matter which it usually contains." But the hay made from such late-made grass must be of little value, because Dr. A. says truly that "this spear grass is so early that if left to stand till the usual time of mowing meadows it loses all its succulent and nutritious properties." This agrees with our experience with respect to the spear grass of Pennsylvania, where it ripens next in order to the early *Anthroxanthum odoratum*, or sweet-scented meadow grass. Still, however, it may be useful by answering one purpose of food in all animals: to stimulate by distention, and to add to the stock of barn-yard manure. The various remedies tried to cure the disease in New York are enumerated by Dr. Arnell. Those that succeeded were:

1. Poultices of soap, rye-meal, and salt, to the legs and feet.
2. A wash of beef-brine, composed of saltpetre, and common salt, applied several times a day, and after washing and rubbing the feet with the bitter-sweet ointment. Of the animals thus treated, one only lost its hoof.

In the treatment of the disease, the first object to be attended to is to remove the cause producing it. This is to be effected by drenches of

castor-oil, or sweet-oil and molasses and water warmed, to which may be added, if found necessary, after the failure to operate of the first dose, half a pound of glauber salts, dissolved in warm water. During the operation of the drench corn meal, rye, or oatmeal, mixed with a large proportion of warm water, and a handful of common salt to every bucket of it, should be freely given. The use of hay free from ergot is as obviously indispensable. A handful of salt should be given every day to promote digestion and give tone to the system. The local applications must be of a stimulating nature to rouse the activity of the circulation and of the absorbents, and to enable the part laboring under a deficiency of vital energy to resume its healthy functions, or to throw off the disease. Fish or beef-brine will answer as well as any, but they should be well rubbed on the feet and legs, for friction greatly tends to assist in restoring the health of the parts. To prevent the appearance of ergot in the grass, care should be taken, when practicable, to supply the meadows with water in dry seasons.

In the Genesee Farmer, 1857, p. 50, was published the following letter, clearly referring to this disease:

Perhaps you are aware there is a complaint among cattle occasionally, in this part of the world, and it may be in many others. I have heard of it in Canada. I do not know the correct name. It is not the hoof-ail, although it attacks the hind feet of cattle, and, if not arrested, the limb will rot off, up to the second joint of the leg, and the animal must be killed, or it will die; after it has proceeded so far as to be incurable, the only way is to knock it in the head.

I write this to inform your numerous readers of a cure we have here, although perhaps the remedy is generally known. It is to cut off the toes of the hind foot (in which only it appears), about an inch horizontal, so as to open the foot sufficiently there for the blood to come out; then put the foot in a stocking with plenty of tar at the toe. If taken in time this will effect a cure. It must be done early, however, when the animal first shows symptoms of the complaint, by a frequent and slight kicking out of the hind foot, as if pricked with something.

I have heard the cause attributed to poisonous hay, such as smut. Do you or any of your correspondents know anything about it? If so, let us have your, or their, experience.

CHILTON FORD.

MORRISTOWN, *Saint Lawrence County, N. Y.*

Again, in the same periodical, 1857, p. 245, we find the following report of this trouble in Portage County, Ohio:

In consequence of the appearance of a severe and fatal disease among cattle in some parts of Portage County (Ohio) the past winter, the Farmers' Association of Edinburg appointed the undersigned a committee to investigate the subject, and ascertain if possible the nature, cause, and cure of this malady. The report of this committee we herewith forward for publication in the Genesee Farmer, together with a resolution adopted by the association at the close of an instructive discussion upon the adoption of the report.

Report.—The disease is not caused by freezing, neither is it what is called hoof-ail, foot-rot, or fouls. Its symptoms seem to be a deadness of the end of the tail, extending upward till in some cases the flesh separates from the bone and falls off. About the same time there is a purple appearance just at the edge of the hair, above the hoof. It then commences swelling, becomes feverish, extending upward to the ankle, and in some instances causing a separation of the coffin-bone from the pastern joint. The lameness is confined entirely to the hind feet. The blood is pale and thin, and in most cases the animal retains a good appetite till near the last. The cause we apprehend to be feeding on hay containing ergot (a parasitic fungus growing within the glumes of various grasses) in considerable quantities. We arrive at this conclusion from the fact that the hay fed by one individual who had lost a large number of cows contained much of this article, and also that the farmer from whom he purchased the hay lost cattle from the same disease, and in both instances cattle fed on other hay were not affected. In every well marked case of this disease it has been ascertained that the hay on which the animals were fed contained the ergot. The hay in which the ergot was found the most, was the kind called the June, or spear-grass, growing in old meadows where the soil is rich and the growth rank.

The severe frost on the 31st of May 1856, is supposed by some to have been the cause of this disease in the grass by destroying the vitality of the seed before it arrived at perfection; while by others it is attributed to the extreme warm growing weather in June causing an overflow of sap.

Although we consider the whole subject involved in much obscurity and uncertainty, and requiring further investigation, yet we are satisfied the best manner of treating the disease is immediate resort to restoratives and a change of diet, whereby an increase of animal heat and vitality is obtained, and at the same time making an application of suitable remedies to the affected parts, by cutting off the toes until they bleed, and blue vitriol moderately applied to the foot has in several instances been found beneficial. A free use of charcoal and salt in various ways is undoubtedly a good preventive; and a careful examination of the hay or grass on which stock is fed is indispensable; if ergot is found in hay it may be removed by threshing or tramping.

Of the specific nature and properties of the ergot in hay, or whether they are identical with that of rye, we are not well informed. The immediate effects of the latter in large doses is well known, but it has no affinity to the ordinary known effects of vegetable poisons. What effect would be produced by its gradual and continual use we are not in possession of sufficient information to warrant us in speaking positively; but we do suppose, after a careful examination, that it operates on the blood of the animal, and unless immediate remedies are applied it proves fatal.

P. BARRON, M. D.,
R. M. HART, Esq.,
J. Y. PEARSON,
JONAS BOND,
Committee.

The following resolution was unanimously adopted:

Resolved (inasmuch as the evidence adduced is conclusive), that ergot in hay is the cause of this disease. The association cannot decide that it is the real cause of a poison being introduced into the system, owing to our inability to analyze this substance; therefore we desire to ask the editors of our agricultural papers for more information, and to obtain a chemical analysis of ergot.

In the Chicago Tribune, March 14, 1884, appeared a letter signed J. Hosmer, containing the following paragraph, which, while it refers the disease to a different cause, evidently describes the same affection:

In 1873–'74, in Chariton County, Missouri, the winter was very severe, the mercury going to more than 20° below zero. The people on the open prairie, mostly Germans who had recently moved there, seeing that the native Missourians provided no shelter for their stock provided none themselves. In the spring from one to three in a flock of eight to ten had the "black leg." It commenced to separate just where the skin joins the hoof. The animal being in great pain, lapped the infected part, and the poison was thus transferred to the mouth. It was nothing more or less than gangrene, as the leg rotted and became putrid.

In the month of February, 1884, a letter written to the editor of the Breeder's Gazette by Cushman Brothers, of North East, Pa., in regard to a strange disease of dairy cattle there was referred to me. This letter, written February 19, and a second one from the same gentlemen, dated March 8, in reply to some inquiries of mine, contained the following information:

The dairy in question contained 18 cows, and the disease appeared about January 1, 1884. The first indication was "cocked" ankles behind, the legs beginning to swell in a few hours, and in two days were "as large as the skin could hold." This swelling only extended as high as the hock joint. In about a week the hoofs began to come off; the parts beneath were red, but there was no formation of pus. The feet were apparently healthy between the claws, the appetite good, the eyes bright, and the cud regularly masticated. The animals had been kept in a warm stable all winter. At the latter date mentioned four had been killed, their appetite having finally failed, two more were very bad, "a scab having formed from top of hoof to several inches above ankle and leg rotting off;" the foot of one animal had come off at first joint above the hoof, the fore feet of none had been affected but with two the fore-

legs were then swelling above the knees. One that had been affected without losing hoofs and had apparently recovered, was taken down a second time. Many people said their feet were frozen, but the owner says they have now changed their minds. He had looked carefully in their mouths for sores but had found none.

This was undoubtedly ergotism, and was so diagnosed by Dr. Germer, the health officer of Erie, Pa., after the Kansas disease had been attributed to this cause.

In recent years several epizootics of ergotism have also been observed in New York by Professor Law, in Iowa by Professor Stalker, and in Colorado by Professor Faville; and it seems probable that when our veterinarians learn to recognize this disease and to refer it to its proper origin, we shall find that it is not an uncommon affection of cattle.

TREATMENT AND PREVENTION OF ERGOTISM.

When the first signs of this disorder appear the most important point to be attended to is to make a complete change of food, and to see that this is of good quality, nutritious, and free from ergot. It would also be proper to give a dose of physic (from one to two pounds of Epsom salts), in order to remove as much as possible of the poison still contained in the digestive organs, and to follow this with soft food, as mashes and roots. In the most severe cases, those in which a part of the limb is already lifeless, treatment will avail but little. The greater number of cases, however, have not advanced to this stage when lameness is first noticed, and these will be greatly benefited by removing the cause, and placing the animal under conditions favorable for resisting the poison. A very important condition is warmth. Even when animals are fed large quantities of ergot they seldom suffer except in cold weather; and consequently in attempting to check the advance of the disease, advantage should be taken of this fact by placing the cattle in warm sheds.

Another condition believed by some to have much influence on the development of ergotism is the water supply. With plenty of water always at hand it is believed that larger quantities of ergot may be taken for a longer time than when the water supply is deficient. In the cold winters which occur over much of our cattle-raising country, it is difficult to induce the animals to take a sufficient amount of water. Holes cut through the ice soon freeze over, and the weather is frequently so severe that the cattle will drink only a few swallows of water before they will leave to seek a shelter from the cutting winds, and when, later in the day, they try to obtain more water, the drinking holes are frozen over. Where ergotism prevails the watering should receive close attention.

Ergotism can probably be entirely prevented by cutting the hay before the seeds have formed. Both in Missouri and Illinois I saw the clearest examples of this. Hay composed of the same kinds of grass, cut upon the same land, was free from ergot or largely infested with it, according as it had been cut green or ripe. This matter is worthy of careful consideration. Hay cut green is more digestible and in every way more valuable than that which is allowed to become ripe and woody; and the latter is much more liable to produce severe disease, such as indigestion, impaction, and ergotism.

This fatal disorder may, therefore, be prevented in the future by proper and careful management; the chief points in this being to cut the hay before the seeds have formed, to see that the animals have a sufficient quantity of drinking water, to keep them in good condition by the liberal use of nutritious food, and to protect them as much as possi-

ble from the inclement weather. When it is found necessary to feed hay which contains a considerable quantity of ergot it is of course doubly important to look after the water supply and the shelter.

GEOGRAPHICAL DISTRIBUTION OF SOUTHERN CATTLE FEVER.

An approximately correct outline of the district permanently infected with southern fever is a matter of supreme importance, not only to the people who live within and near this district, but to those interested in live-stock in every part of the country. The losses which occur every summer, and which in some years have been really disastrous to the stock owners of certain sections, have been largely the result of ignorance of the districts from which it is dangerous to bring cattle in summer, and to which adult cattle cannot be taken with safety at any season of the year, unless they are to be slaughtered for beef within a short time after their arrival.

An attempt to make efficient laws to guard against this malady by regulating the movement of cattle from infected localities has generally failed to give relief, because these districts could not be accurately designated. States, therefore, as well as individuals, have been unable to protect themselves, and the losses have gone on year after year in spite of individual precautions and State laws. The cheap cattle of Georgia, Alabama, Mississippi, Arkansas, Southeastern Virginia, and other infected sections are at times carried to the most remote sections of the country, and when this is done in spring or summer extensive and fatal outbreaks of southern fever among the susceptible animals which cross their trail or mix with them upon their pastures is the general result.

Last year such outbreaks of disease are known to have occurred in New York, New Jersey, Pennsylvania, Maryland, Virginia, West Virginia, Ohio, Illinois, Missouri, Kansas, and even in Dakota. Colorado and Wyoming seem to have escaped, notwithstanding the introduction of Southern cattle, and this was probably due to the peculiar climatic conditions, the excessive dryness of the atmosphere preventing the multiplication of germs and soon destroying them.

It is evident, however, that this disease may be carried to most parts of the country, and that before anything can be accomplished toward preventing the very important losses which are now annually caused by it, we must have more accurate knowledge of the section from which cattle are liable to carry the infection. To obtain the information necessary to map out the infected district special agents have been employed, who have carefully traversed every county along the border-line of this district, and have investigated the cattle diseases with sufficient detail to locate the limits of the infected district in most counties with very great accuracy. In some counties a sharp line cannot be drawn, because it does not exist, but in such cases the line has been drawn sufficiently toward the uninfected district to embrace, as is believed, all the territory that was really infected at the time of examination. As this district is being continually enlarged by a gradual though very slow advance of the infection, it is not safe to buy cattle near this line for shipment to the North in summer, unless a careful personal investigation is made by the purchaser at the time.

The infected part of the South is clearly shown on the accompanying maps. To establish the boundary-line of this district beyond controversy our special agents have carefully reported the individual experience of thousands of farmers, and others who have moved cattle either northward or southward in the vicinity of this line. These reports are far too numerous and voluminous to publish in detail, and, consequently, a simple résumé of the facts as they are known to exist is all that we have attempted to give in this report. The location of the border-line of the infected district is as follows:

VIRGINIA.

The northeastern extremity of the line is in Accomack County on the Atlantic seaboard. The permanent existence of the disease on this peninsula has not heretofore been suspected by the country at large. A few facts had come to our notice within the past year or two which seemed to indicate that certain outbreaks of southern fever in Maryland had followed the introduction of cattle from Northampton County, which covers the extreme southern part of the peninsula. At the time it seemed impossible that this disease could have secured a permanent lodgement so far north, and the reports were scarcely credited.

A careful examination of the peninsula, however, has demonstrated the existence of the infection of southern cattle fever throughout Northampton County, and extending for 2 or 3 miles across the boundary into the southern part of Accomack County. The infection seems to have been in Northampton County so long that no one remembers a time when it was absent. It is said that there are local laws prohibiting the movement of cattle from Northampton to Accomack at any season of the year, but that recently they have not been strictly enforced. In 1880 a considerable number of cattle that had been running upon commons in Accomack County, 2 or 3 miles from the southern boundary, died with symptoms of southern fever. It was found by investigation that more or less cattle had died from pasturing on these commons every summer for the past ten years.

In April, 1881, a drove of about 50 head of cattle was collected in Northampton County and driven to market across Accomack. At Pungoteague a stop of several hours was made, and here at least six head of cattle contracted the disease during the following summer and died. Two miles farther north another halt was made for dinner, and in this vicinity nine of the native animals died. Twenty miles north of this the herd seems to have stopped again, and here a large number of native cattle died.

There seems to be no reason to doubt, then, that Northampton County has long been infected, and that the cattle from that section when driven among susceptible animals produce the same fatal results as has long been recognized to follow a similar movement of Texas and Gulf-coast cattle. The infected part of Accomack County is very narrow, perhaps not more than 5 miles wide, and it is said that the disease is more malignant toward the seacoast than it is in the parts which border on the bay. This is in harmony with the fact that southern fever is known to have existed along the seacoast in North Carolina and Virginia for many years before it invaded the interior.

A careful investigation of the counties north of the Rappahannock River failed to reveal any trace of the disease. Not only were all the cattle apparently in good health, but imported cattle had remained free from disease after their introduction. Several instances were related

of bulls being brought from North or West and continuing to thrive in their new home. According to all the information attainable, then, there is no permanent infection north of the Rappahannock River.

Coming south of this river, we find that cattle brought from Gloucester and Matthews Counties to sections of the State farther north and west infect pastures and thus destroy native animals. The facts obtained indicate that Middlesex County has become entirely infected, but we were unable to obtain evidence of any permanent infection in Essex County. In King and Queen County the infection has reached the pastures in the vicinity of King and Queen Court House within the last four or five years, and it now survives there through the winter. Ten miles north of this cattle are susceptible to the disease and suffer when on the same pastures with others from south or east of that locality. While therefore the southeastern part of this county is certainly infected the greater part is still free. The same phenomena in regard to the extension of the disease that has been noticed in other parts of the South were also apparent here. The effects of the disease had been apparent for twenty years south and east of the courthouse, but the pastures here had not become infected until about five years ago, and since then cattle have been frequently lost. In Caroline County there was an outbreak of disease in 1881 caused by cattle from Gloucester County.

In King William County we find the infection permanently located on the Pamunkey River 8 or 10 miles above the New Kent County line, where it seems to have been for the past twenty years.

In Hanover County the permanent infection has been at Hanover Court House and Ashland for a considerable number of years. It is well known to the inhabitants that cattle brought from north or west of these places are nearly certain to die either the first or second summer after their arrival. The infection has extended but little beyond these two points.

Henrico appears to be entirely overrun with the infection. All the cattle sold from this and the surrounding counties go to Richmond either to be killed for beef or to be shipped by boat to other markets, and consequently there is little opportunity to collect instances of disease caused by cattle carried from here to uninfected localities. On the other hand it is admitted pretty generally by those who handle cattle that it is very dangerous if not absolutely fatal to bring these from the elevated sections of the State to any part of this county.

In Goochland County there have been very few cases of disease for a long time, but the southeastern extremity of the county is recognized to be dangerous to northern cattle. Farms on the James River three or four miles above Goochland Court House lose a few animals from year to year with southern fever. There is, however, little opportunity for the disease to occur, since the traffic in cattle is not extensive. Animals are not brought from north or west because of their liability to become affected, and they are not brought from the South because this is believed to be dangerous to the natives.

Powhatan County is undoubtedly infected, and has been in this condition for many years. It is reported by all the farmers along the James River to be absolutely fatal to cattle to be brought from north of the river to the south side. They suffer to the same extent when simply carried from the north to the south bank as when the distance is greater. Cattle from this county have long been considered dangerous to the native stock with which they came in contact when being driven to localities farther north. The introduction of this disease is not remem-

bered by the oldest inhabitants, but so far back as the memory of man goes the present conditions have prevailed.

Cumberland County does not appear quite so thoroughly infected. At Trenton Mills and McRea's there is no doubt of the permanent infection, but the southern extremity of the county still seems to be free from it. In the counties along the river it is very plain that the sections immediately adjacent to the river have been longer infected and that the disease here is more generally diffused and more virulent than in the same counties at a greater distance from the water. And accordingly as we attempt to investigate the condition of other sections we encounter the difficulty of finding a smaller number of cases and a greater uncertainty in the minds of the inhabitants as to whether the native pastures really hold the infection from year to year, or whether each outbreak is the result of a fresh importation.

In Buckingham County our reports confirm the statements that were made last year. The infection extends up the south bank of the James River to a point slightly beyond the confluence of the James and Slate Rivers. From here the boundary line of the infected district passes up along the west bank of the Slate to Diana Mills; then the direction is a southeastern one to the vicinity of Gravel Hill, and to McRea's, in Cumberland County.

In Amelia and Nottoway Counties it has been impossible to trace any line or even to demonstrate the complete infection of the territory. It is generally admitted that twenty years ago and longer there was a complete infection of this district, but of late years there has been much less disease and it has become possible to bring in cattle from north and west with safety. In these counties there are no fences, and each man must necessarily keep his cattle upon his own pastures; as a consequence there is none of the indiscriminate mixing of cattle which used to occur, and the chances of contagion are greatly lessened.

While there have been considerable losses in Prince Edward County there is little evidence of permanent infection, except, perhaps, in the extreme eastern part. Most of the cases seem to have been the result of pasturing on commons that had been frequented by animals from Lunenburg County.

In Lunenburg there is no doubt of permanent infection. It is dangerous to bring cattle from west or north into this county, and, on the other hand, cattle from this county have frequently spread disease when driven toward the west or north.

In Charlotte County the boundary of infection becomes plainer and follows very nearly the line of the Richmond and Danville Railroad in its whole course across the county.

From the point where this railroad crosses the Staunton River to the North Carolina boundary, the line of infection was definitely located in my last year's report. The accompanying map delineates the portion of Virginia permanently infected with southern cattle fever as correctly as this could possibly be done. Parts of the line have been retraced three and four times in order to have it satisfactorily located.

NORTH CAROLINA.

The Blue Ridge Mountains of North Carolina are now looked upon by the people of this State as the practical boundary line of the district permanently infected with southern fever. At some points, as in Wilkes County, the infection has not quite reached the mountains, and at one other point it has crossed the ridge and invaded Henderson

County. The laws of the State, however, make the Blue Ridge the line, and prohibit the movement of cattle from the eastern counties at all seasons of the year.

SOUTH CAROLINA AND GEORGIA.

The whole territory of South Carolina seems to have been overrun with this infection. The Blue Ridge Mountains, which form a part of the northwestern boundary of the State, have here been crossed by this contagion and are no longer to be considered as the line. The infected district beyond these mountains is, however, at present of small extent, and the advance is so slow as to be scarcely appreciable.

The small portion of Georgia which has heretofore been considered free from this infection is being rapidly overrun; and it is now doubtful if any of even the northern tier of counties can be considered entirely free. The mountain sections are not so thoroughly infected, and it is probable that Towns, Union, and Fannin Counties are practically free from the permanent infection.

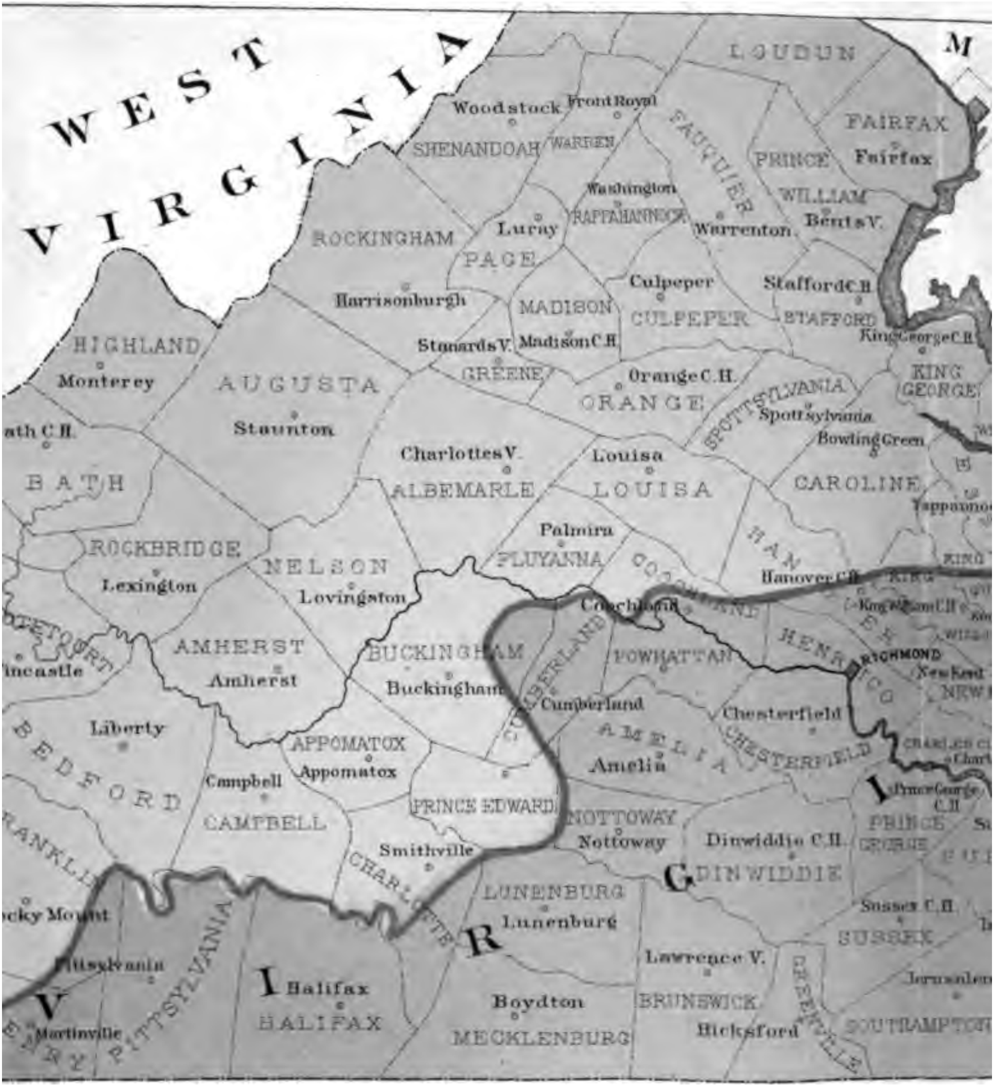
Whitfield and Murray Counties have been quite thoroughly inspected and the commons of both found to be infected in all parts. Many of the farms are also infected, but some still remain free, especially near the northern boundary. Cattle taken from these counties to the mountain ranges of Gilmer for pasture have not so far as has been ascertained caused any outbreaks of disease. This is probably due to the fact that Gilmer County is also pretty thoroughly overrun.

Here, as in many other localities, there are evidences of a different intensity of the contagion in various parts of the counties, but more particularly in different sections of the State. Thus, cattle which have pastured on the ordinary infected ranges of Whitfield County without harm, have become diseased as a consequence of feeding along the trails and on the commons where cattle from Southern Georgia had lately grazed. The movement of bovine animals from one farm to another or from one county to another is also considered dangerous. The fatigue induced by driving is without doubt one of the factors in producing the disease in such cases. Even cattle from the extreme south often succumb when exhausted by long journeys. Similar facts have long been noticed with other diseases, and particularly with anthrax, cattle which have resisted the contagion on the infected farms becoming victims to the virus already within their bodies, when their vital resistance is lowered by great fatigue.

At Dalton there is a probability that permanent infection existed before the war, but not to the same extent as at present. The cattle driven from South Georgia to provision the armies, and later those brought by the refugees returning to their homes, are believed to have been the means of distributing and intensifying the contagion throughout Northwest Georgia.

TENNESSEE.

The line of the infected district crosses the boundary line between Georgia and Tennessee near the western slope of the mountains, and follows a northwesterly direction to Parkville and Benton, in Polk County; then its direction is nearly directly west to Cleveland, Bradley County, and to Snow Hill and Harrison, in James County. From this point the river becomes the line across Hamilton County, Chattanooga and the Chickamauga Valley, having been infected for a long time. The southwestern part of Polk and the southern parts of Bradley, James, and



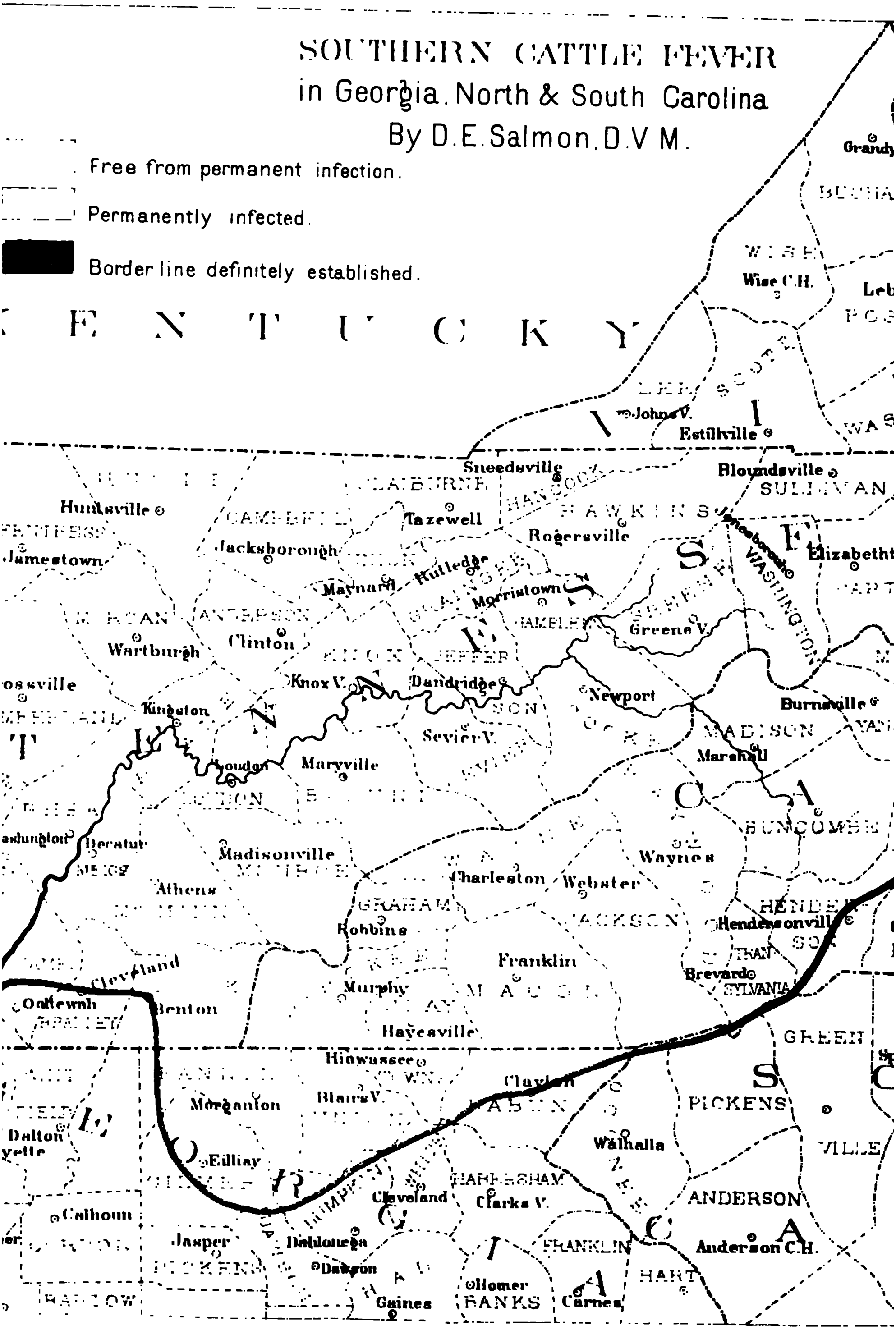
Free from permanent infection

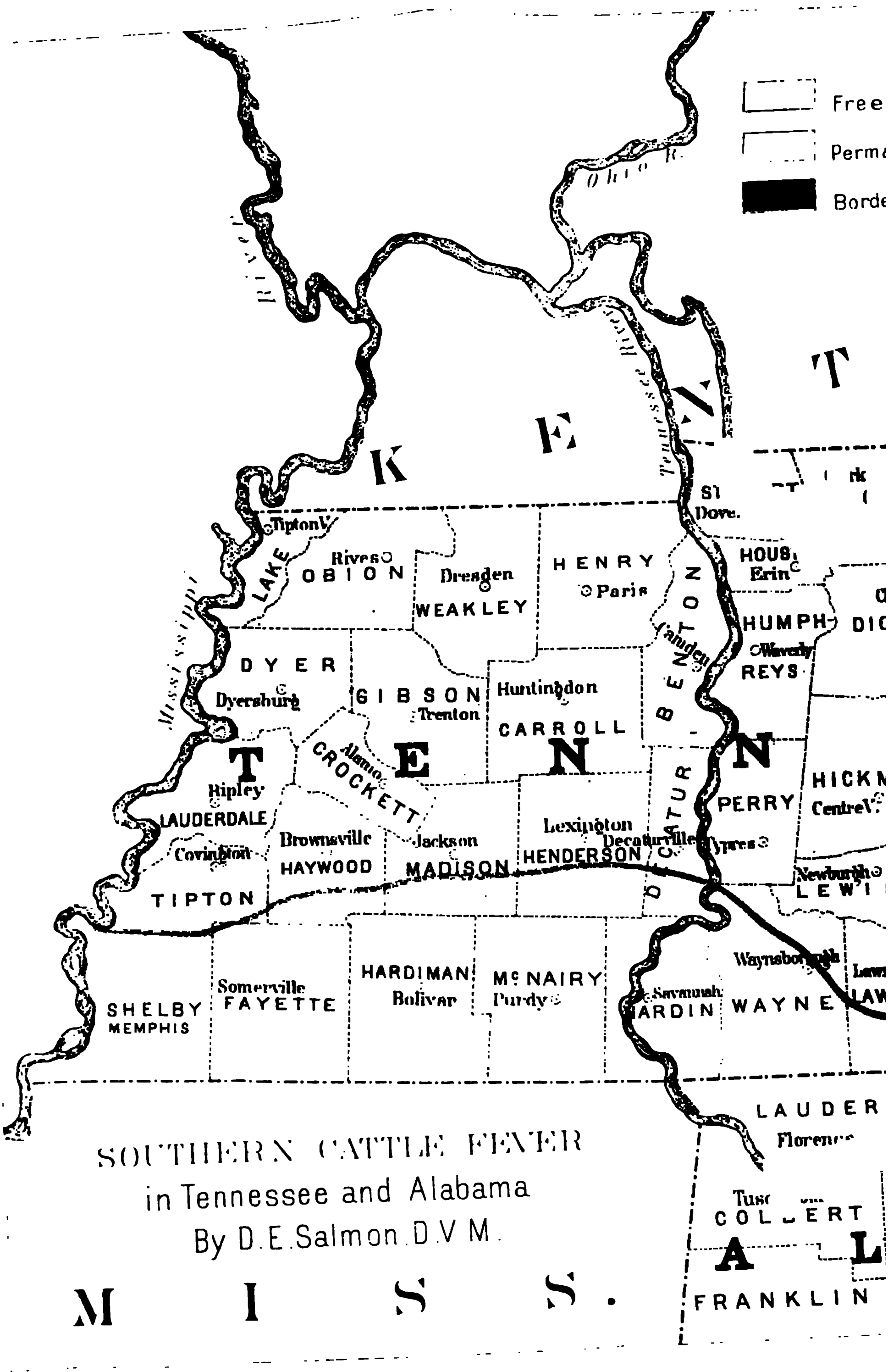
Permanently infected.

Border line definitely established.

SOUTH

B


SOUTHERN CATTLE FEVER
in Georgia, North & South Carolina
By D. E. Salmon, D.V.M.
Free from permanent infection.
Permanently infected.
Border line definitely established.
KENTUCKY
Johns V.
Estillville
Wise C.H.
Sneedsville
Blountsville
SULLIVAN
Huntsville
Tazewell
HAWKINS
Rogersville
Jamestown
Jacksborough
Elizabetht
Maynard
Rutledge
Morristown
WASHINGTON
Greene V.
Wartburgh
Clinton
Knox V.
Dandridge
Newport
Burnsville
Kingston
Sevier V.
MADISON
Marshall
Loudon
Maryville
BUNCOMBE
Decatur
Madisonville
Waynes
Athens
Charleston
Webster
GRAHAM
Robbins
JACKSON
Hendersonvill
Franklin
Brevard
Cleveland
Murphy
Benton
Hayesville
GREEN
Hiwassee
Clayton
PICKENS
Morganton
Blairs V.
Dalton
Walhalla
Ellijay
HABERSHAM
ANDERSON
Calhoun
Cleveland
Clarks V.
Jasper
Dahlonega
FRANKLIN
Anderson C.H.
Dawson
Homer
HART
Gaines
BANKS
Carnes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Borde
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River
Mississippi
Tennessee River
K E N T
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Rives
OBION
LAKE
Dresden
WEAKLEY
HENRY
Paris
Dove.
HOUS
Erin
HUMPH
REYS
Waverly
DYER
Dyersburg
GIBSON
Trenton
Huntingdon
CARROLL
BENTON
Camden
T E N N
Alamo
CROCKETT
Ripley
LAUDERDALE
Covington
TIPTON
Brownsville
HAYWOOD
Jackson
MADISON
Lexington
HENDERSON
Decaturville
DECATUR
PERRY
HICK
CentreV
Newburgh
SHELBY
MEMPHIS
Somerville
FAYETTE
HARDIMAN
Bolivar
McNAIRY
Purdy
Savannah
ARDIN
Waynesborough
WAYNE
LAUDER
Florence
COL ERT
A L
FRANKLIN
M I S S.
SOUTHERN CATTLE FEVER
in Tennessee and Alabama
By D.E. Salmon D.V.M.

Hamilton Counties are, therefore, permanently infected. The district infected is here, as we have found to be the case elsewhere, extending slowly toward the north; and though this extension is slow it is apparently continuous, and the territory once overrun is seldom redeemed from the scourge. The points which we have mentioned as existing on the border line of the district have only been infected within a few years, and, as elsewhere in newly infected sections, it is the commons rather than the farms that are dangerous, and even the commons are not uniformly affected.

In Marion County the line of infection passes in a northwesterly direction up the east side of the Sequatchie Valley and within one or two miles of the Sequatchie County line, and then crosses the valley and down the west side for five or ten miles, passing around the mountain range and taking a southwesterly direction to the vicinity of Jasper; from here the direction is again northwesterly to Decherd, in Franklin County, the greater part of this county being apparently permanently infected. From Decherd the direction of the line is slightly south of west to Fayetteville, in Lincoln County, and from this point along the Elk River to the Alabama State line in the vicinity of Veto Station. The southern part of Lincoln County is what is called the barren region, and has been infected for many years. In the vicinity of Marbut's the line again crosses into Tennessee, taking a northwestern direction, and at the county line between Giles and Lawrence Counties is about five miles north of the Alabama State line. On the boundary between Lawrence and Wayne Counties this line is 10 miles north of Alabama. At this point there is a sudden bend toward the north, the line crossing to the northwestern corner of Wayne County, taking in about one-fifth of Decatur County and all of Harden. In Henderson County it reaches as far north as Shady Hill, then passes directly west to the vicinity of Mifflin, in the same county. From here the direction is slightly south of west to Denmark, the boundary between Madison being crossed 2 miles north of Hardeman County; from here the direction is westerly to Stanton Depot, in Haywood County, and onward toward the southwestern corner of Haywood and along the northern boundary of Shelby to the Mississippi River. All of Shelby and Fayette Counties appear to be infected, while Tipton, as far as we have been able to learn, is free from any infection.

This concludes our examination of the district permanently infected with southern cattle fever for the year. It will be seen that a considerable portion of Tennessee has already become infected. Even the mountainous counties in the southeastern part of the State have been invaded, while in the river valleys of the central part of the State the line has reached considerably farther toward the north. Along the whole line of the infected district in this State, as in the other States previously examined, we have found the same history of the extension of the permanently-infected district. At some points this extension has been insignificant or is scarcely noticeable within the last quarter of a century, but in the situations more favorable to the progress of the disease there has apparently been a regular advance of from one to four miles per year. This history coincides substantially with what was learned of the progress of the disease in Virginia, North Carolina, and Georgia. As a consequence of these facts there can be no longer substantial reason to doubt the continued extension toward the north of the district permanently infected with this disease. Considering the extreme temperature which occurs in the mountains of southeastern Tennessee and in the part of this State located in the Mississippi Valley,

we can scarcely hope that the winters in any considerable part of the stock-raising section of the country will be sufficiently severe to prove a permanent check to the extension of this contagion.

It is proposed to continue the examination of this district across Arkansas, Indian Territory, and Texas, to the Rio Grande River, and it is believed that a definite location of this line will be of great assistance to those engaged in the live-stock industry in the whole southwestern part of the country. The mortality among thoroughbred cattle taken south of the border line of the permanently infected district is so great that it has become a matter of importance to buy animals which have acquired a certain amount of immunity from this disease. It is believed by many breeders that by establishing breeding farms just within the line of infection that there will be a smaller mortality from the disease, and that the animals raised under these conditions will still be able to resist its effects in a very perfect manner. Already such farms have been established in Southeast Kansas and Southern Missouri, under the belief that animals raised in this locality will prove insusceptible to the disease when carried further south, but the great uncertainty which at present exists with regard to the exact location of this line makes it extremely doubtful if these farms have been correctly located. A number of extensive breeders who have a very intelligent idea of the nature and effects of this disease have recently expressed to me their high appreciation of the work now being done by the Department of Agriculture toward establishing the boundary of this infected district. It is believed that definite knowledge in regard to this will relieve them from many of the causes of embarrassment connected with the shipment of thoroughbred cattle to the South.

INVESTIGATIONS OF SWINE PLAGUE.

In a communication of M. Pasteur to the Paris Academy of Sciences (Comptes Rendus, 1883, p, 1163) it was asserted:

1. That the microbe of swine plague is a dumb-bell micrococcus.
2. That pigeons are very susceptible to the virus, and passing this through a succession of these birds increases its activity.
3. That rabbits are also susceptible, and passing the virus through a succession of these animals attenuates it to such an extent that if pigs are inoculated with it they only contract a slight illness which grants them immunity from subsequent attacks.

To these assertions Dr. Klein (Vet. Jr., 1884, July, p. 39) replies:

1. That M. Pasteur has overlooked the true microbe, and that this is a bacillus and not a micrococcus.
2. That all of his (Klein's) inoculations of pigeons with virus taken directly from diseased swine—virus which invariably produces the disease in swine and other susceptible animals—and with his artificial cultures of the organism of swine fever, produced absolutely no effect, either general or local.
3. That it is impossible to say whether M. Pasteur's rabbits died of swine fever or of septicæmia, though he (Klein) had shown in 1877 that rabbits are susceptible to swine fever when inoculated from material directly derived from the pig.
4. He adds in an addendum that he has recently satisfied himself that the artificial cultivation of the virus in the organs of mice or rabbits by inoculating these from diseased swine will produce a mild form

of swine plague from which the animal quickly recovers, and is thereby protected from the disease.

It is very evident that before any safe method of protective inoculation or vaccination can be adopted we must be satisfied as to the nature of the virus. Rabbits and mice are both subject to septicæmia, and it is quite certain, from the difference in the microscopical appearance of the germ described by these two investigators, that either the one or the other had cultivated and inoculated with a septic virus. Dr. Klein does not hesitate to say that it seems probable to him that, "as in the case of the microbe of fowl cholera, M. Pasteur did not work with pure cultivations of the microbe of swine fever." M. Pasteur will doubtless say, on the other hand, that Dr. Klein has evidently been cultivating and inoculating with the septic vibrio. Both cannot be right in their belief that they have been working with the true germ, and, consequently, it is very probable that both sets of hogs were not protected from the genuine swine plague. Each has made many inoculation experiments, each has cultivated his germ through a number of cultivations in purity as he supposes, and each believes that he has produced the true swine plague with such cultivations; but one of them is wrong; vaccination with the virus of one will fail in practice, and if the wrong virus is so easily obtained it becomes doubly important to know how to discriminate between them.

In former reports I have given details of experiments which, if correctly stated, demonstrate beyond question that the microbe of swine plague is a micrococcus. These experiments were made and the accounts of them published in advance of those of M. Pasteur, and the evidence furnished was all that could reasonably be required to decide a scientific question of this kind. Dr. Klein, however, has published evidence which on its face is equally conclusive in his favor; and as it is not likely that two different diseases resembling each other so closely in symptoms and lesions, but having such dissimilar virus, have been investigated, the most reasonable conclusion is that one is mistaken in his conclusion. It is necessary, therefore, to review certain points in the investigations and to bring forward such new evidence as shall be required to remove these uncertainties.

1. *The microbe of swine plague.*—As I have shown elsewhere (*Science*, 1884, p. 155) Dr. Klein was first to demonstrate the presence of micrococci in the tissues of animals that had suffered from swine plague, but he did not at that time (1876) attribute, nor has he at any time subsequently attributed, the cause of the disease to this organism. On the contrary, he published a long series of investigations in 1878 (report of the medical officer of the Local Government Board) from which he concluded that the true germ of this disease is a bacillus, and in his last paper reiterates this conclusion and asserts that the micrococcus is entirely an epiphenomenon (Vet. Journal, July, 1884, p. 39–47).

In my report for 1880 (Department of Agriculture, Special Report No. 34, pp. 22–24), I published experiments showing that the blood of sick, not dead, hogs, which had been received into vacuum tubes that were thrust inside the vein with proper precautions before being opened, and were then immediately withdrawn and hermetically sealed, contained micrococci and no other organisms, and that hogs inoculated with this blood contracted a severe form of swine plague. This organism was found to exist in the virulent liquids (blood, peritoneal effusion, &c.), in three distinct outbreaks of the disease which were investigated at that time. This was the first discovery recorded, so far as I am aware, of the existence of micrococci in the blood of the affected swine before

death; and it has a very important bearing on the etiology of the disease, since a *post mortem* development of the germs is out of the question, and they were found in situations to which there was no direct communication from the outside of the body.

In my next report (Department of Agriculture, Annual Report, 1881 and 1882, pp. 267–269) I gave the details of experiments which demonstrated that these micrococci after they had been carried through six cultivations in considerable quantities of liquid were still capable of producing very marked cases of the disease. This was, I believe, the first satisfactory evidence of the pathogenic effect of the micrococci in the disease known as swine plague; and I desire to call attention to the fact that these inoculations were made January 17, 1881, or more than fourteen months before the discovery of the same organism by M. Pasteur and Thuillier.

To establish the connection of the bacilli with the cause of the disease, Dr. Klein relies upon the following evidence:

1. The presence of bacilli in microscopic sections of the tissues.
2. The multiplication of bacilli in the artificial cultures of the virus.
3. The production of disease by inoculations with the cultivated bacilli.

He has not forgotten that in his first report he described micrococci and not bacilli as existing in the tissues, but there is an evident attempt to explain this by conveying the impression that these were found exclusively in situations where they might be derived from external sources. For instance, in his last paper (Vet. Journal, July, 1884, p. 41) he says:

> Preparing sections through the typically ulcerated mucous membrane of the large intestine, staining these in aniline dyes, and examining them under the microscope, I find this: In the superficial parts of the necrosed membrane are present large numbers of micrococci of various kinds, chiefly varying in the size of the elements and in the mode of aggregation. These micrococci stain well in Spiller's purple and in methyl blue, and are present only in the necrotic parts of the ulceration, in which they appear irregularly distributed. But in the depth of the tissue, and extending in many cases into the inflamed sub-mucous tissue, are seen streaks and clumps of minute rod-shaped bacteria, which coincide as regards size (length and thickness) with the bacilli which I described in my former memoir, the single organisms being about 0.001 to 0.004 ^{mm}. long, and about a third or a fourth as thick.

In his first report he described the situation of the micrococci in the intestine somewhat differently, as follows:

> From, and even before the first signs of necrosis of the mucosa, viz., when the epithelium begins to break down and be shed from the surface, there are found masses of micrococci, which in some ulcers occupy a great portion of débris. (Report of the medical officer of the privy council and local government board, 1876, p. 98.)

Again, in regard to the ulcerations of the mucous membrane of the tongue, he says in his last report:

> I have seen in the superficial parts of the ulcers large clumps of micrococci, but in the depth of, and extending between the inflamed muscular tissue I have found the same rod-shaped organisms as mentioned above; they are chiefly in spaces between the bundles of the inflamed connective tissue, forming here streaks of longer or shorter chains. (Page 42.)

In his first report this was stated as follows:

> In the ulceration of the tongue just mentioned, and at a time when the superficial scab has not been removed, I have seen masses of micrococci situate chiefly in the tissue of the papillæ, but at some places reaching as far deep as the inflammation extends. (Page 99.)

In regard to the similar lesions of the epiglotis the following language was used:

> I have before me preparations through the epiglottis, the submucosa of the posterior surface being in a state of necrosis, and near the edge so broken down as to

leave there a deep ulcer, while the mucous membrane of the anterior surface is only slightly inflamed in its submucous tissue; in this I find lymphatic vessels filled with micrococci, &c. (Page 100.)

As to the appearance of the lung his last report says:

Sections through the diseased parts of the lung reveal, in preparations stained as above, the presence of large numbers of micrococci in the cavity of the bronchi and air vesicles, but not in all lungs, since I have found lungs in which they were altogether absent. But there are always present in larger or smaller clumps the same minute rod-shaped organisms as mentioned above. They are imbedded in a coagulum filling the air vesicles, or they block up a blood-vessel in the wall of a bronchiole or air vesicle. In the air vesicles I have seen exudation cells, white-blood corpuscles containing clumps of the rods; they are well brought out by Spiller's purple. In the air vesicles of some lungs I have seen them grow to very long chains, leptothrix, ten, twenty, and more times the length of the single rods. These rods were present, not only in the air vesicles, but also in the tissue itself, both of the walls of the air vesicles as well as of the smaller or larger bronchi. (Pages 41, 42.)

In his first report there is a most radical difference in the description of the situation where the micrococci were seen:

In the infiltrated, firm, more or less disintegrating parts I find great masses of micrococci filling up capillaries and veins, and also contained in lymphatics around arteries. They may be found also in minor bronchi which have been completly blocked up by cheesy inflammatory products, but there the masses of micrococci, conspicuous by their blue coloration in hæmatoxylin preparations, are generally present in greater or smaller lumps between the outer surface of the plug and the wall of the bronchus.

The pleura is much swollen, and contains great numbers, continuous layers, of lumps of micrococci. The free surface of the membrane is in many parts covered with them. The exudation fluid is also charged with them, as has been mentioned above. (Pages 100, 101.)

That is to say, in 1876, Dr. Klein was able to find the micrococci not only in the necrotic parts of the ulcerations, but he found them *from and before the first signs of necrosis;* he found them *extending as deep into the tissue of the tongue as the inflammation extended*, and in the epiglottis *at a point where the submucous tissue was only slightly inflamed he found the lymphatic vessels filled with micrococci.* In the lungs, instead of the micrococci being confined to the cavity of the air vesicles and bronchi as he desires us to understand from his last report, he really found them *in the infiltrated and firm parts, filling up capillaries, veins and lymphatics.* They had even penetrated to the pleura *which contained great numbers and continuous layers of them; the free surface was covered with them, and the exudation fluid was charged with them.* Their presence in the pleural effusion is sufficient evidence that cross-section of bacilli had not been mistaken for micrococci in the tissues; and it may, consequently, be accepted as beyond question that this organism existed at the points named in the report of 1876.

In the last report it is stated that the rods (bacilli) are found "in the bronchial exudation, in the juice of the lung tissue, in the peritoneal exudation, and occasionally, but not generally, also in the blood already in the fresh state." Sections made through the fresh or hardened, swollen mesenteric and inguinal lymph glands are said to reveal the presence of clumps of the same minute rod-shaped organisms. Looking at a clump of these organisms, one imagines them at first to be a zooglœa of micrococci, but using oil-immersion lenses and Abbe's substage condenser it becomes certain that they are undoubted rods—some smooth and uniform, others more or less "beaded."

In the results of the examination of the tissues it will be seen that, with the exception of the lymph glands mentioned, the bacilli of the last report have little if any advantage in situation over the micrococci of the first report. And if we consider that the organisms of these glands so closely resemble micrococci that it requires oil-immersion lenses

and an Abbe condenser to make a distinction, and that even under such favorable conditions some of the rods are more or less "beaded," the reader will not feel so certain that they are undoubted rods as is Dr. Klein.

The examination of the tissues of mice and rabbits which have died after inoculation with the more or less septic liquid of dead hogs cannot be accepted as throwing any satisfactory light on so difficult a problem, since others cannot fail to have the same doubts in regard to Dr. Klein's experimental animals that this gentleman is so free to express in regard to those of M. Pasteur. The question as to the organisms found in the tissues of animals so susceptible to various forms of septicæmia as mice and rabbits after they have been inoculated with morbid products from hogs which have died of a disease in which local necrosis and gangrene is not uncommon, is one which can only complicate the real issue without in any sense elucidating it. Indeed, when Dr. Klein tells us that he has "seen a good many pigs inoculated with culture of the bacterium of swine fever, which beyond the swelling of the glands and beyond a transitory rise of the body temperature on the second and third day, by one or even two degrees C., showed no other signs," we have strong suspicions that the slight trouble produced was of a septic nature rather than a mild attack of the destructive swine plague. The period of incubation in swine plague is much longer than that of septicæmia; sometimes it is three weeks; generally it is from twelve days to two weeks, and it is only by the use of enormous doses of virus that I have succeeded in reducing it to four or five days; and, therefore, when we are told that in these mild attacks the period of incubation was but two or three days, and that in at least one case there was a rise of temperature within twenty-four hours (*Ibid.*, p. 43), the appearances are certainly very much more in favor of septicæmia than swine plague. Certain it is that in none of my numerous inoculation experiments has there been a rise of temperature within so short a time. As I write this I have just returned from making a *post mortem* examination of a pig killed in the last stages of the acute form of the disease; this was one of a lot of three inoculated with a virus so virulent that not one of a considerable number of swine that have been inoculated with it during the last three months has recovered. With so virulent a virus one would expect the incubation to be at its shortest duration, and yet neither of these three showed any appreciable signs of disease up to the twelfth day. All sickened at about the same time, and to-day, the fifteenth day, all were so extremely ill that the most careful prognosis would be death of all within forty-eight hours.

In animals which have died from the disease and on which a *post-mortem* examination was not possible immediately after death, I have also found bacilli in the peritoneal and plural effusion, and even in the blood. A photograph of some of the peritoneal effusion dried on a cover-glass at the time of the autopsy, and afterward stained and mounted, shows these very plainly; this photograph has been reproduced by the heliocaustic process and accompanies this report as Plate XII. No doubt bacilli would also have been found in the solid tissues of this animal; but these organisms were the result of changes which occur either shortly before or after death, and have not been found in any of the numerous animals which I have destroyed for examination when in the earlier stages of the disease. In such cases the peritoneal, the pleural, and the pericardial effusions, and usually the blood, are found to contain motionless micrococci of the figure-of-eight form, but often united in chains and various-shaped clusters.

In the many cultivations which I have made from material obtained from slaughtered animals I have never found bacilli except in a very few cases where the virus was not obtained until after contact with the air, where the vacuum tubes had not been properly sealed, or where the animal was not slaughtered until the last stages of the disease. A photograph of a preparation made from one of these cultivations is reproduced in Plate XI. It seems to be a perfectly pure cultivation of micrococci so far as careful examination with the microscope is able to determine, and it was so virulent that three pigs inoculated with it all contracted the disease and all died.

In my most recent investigations I find that the peritoneal effusion is often impure in the last stages of the disease. In such cases a variety of organisms appear in the cultivations made with this liquid, but pure cultures of micrococci are still obtained from the pleural effusion, or in those rare cases where this too is impure the pericardial fluid and blood have yielded pure cultures of micrococci. A fact of great importance is that no pure cultures of bacilli have been obtained, and that where but a single species of organism has multiplied this has invariably been a micrococcus.

Having obtained such results from my investigations, and having repeated them over and over again, and confirmed them with virus from various parts of the country, I cannot but conclude that swine plague is due to a micrococcus, and that the disease produced by Dr. Klein's cultivated bacilli was a form of septicæmia. And this conclusion is confirmed by the short period of incubation in his cases, and the fact that many of his animals showed no signs of disease other than a slight rise of temperature and an enlargement and congestion of the lymph glands.

The following record of experiments contains the most important of those which have been made since my last report, and is a continuation of the evidence upon which the above statements have been made:

Experiment No. 1.—Two pigs were inoculated June 28, 1883, with virus dried on quills and sent from Indiana. It was obtained by killing a sick pig and immediately dipping the quills in peritoneal and pleural effusion and the exudation liquid from the lungs, and drying this after the manner practiced for preservation of vaccine lymph. In this case the animal from which the virus was obtained did not have a very severe form of the disease. For inoculation the virus on three or four quills was rubbed up with 2^{cc.} of salt solution and injected under the skin of thigh. The fourth day (July 2) there was elevated temperature ($102\frac{4}{5}$° and $103\frac{1}{5}$° F.) and slight redness at the point of inoculation. The fifth day there was diffused redness on the inner side of both thighs, an eruption of small papulæ on the thin parts of the skin and an increased elevation of temperature ($103\frac{3}{5}$° and $104\frac{4}{5}$° F.). July 5 to 9 the temperature remained at or above 105° with one, and reached its highest point on the 7th, being then $105\frac{3}{5}$°, and the eruption was very plain and extended over the greater part of the surface of the body. From this time they began to improve, and in neither case was the disease fatal.

This was one of a number of inoculation experiments made to obtain a reliable virus for experimental purposes, and is recorded to illustrate the above remarks in regard to the period of incubation.

Experiment No. 2.—Four hogs were inoculated July 7, with virus also from Indiana, and preserved in the same way as the other, but was obtained from an outbreak which was much more virulent and fatal.

This was also suspended in salt solution and injected hypodermically in the dose 2cc. to 3cc. at the inner side of the thigh.

To and including July 17, or for the first ten days, there were small, hard swellings at the point of inoculation, but no positive signs of disease, and the appetite remained good. There were considerable variations in the temperatures, but it is doubtful if this had any pathological significance. July 18, three were evidently sick, with temperatures of $102\frac{3}{5}°$, $105\frac{1}{5}$, and $106\frac{3}{5}°$ F.

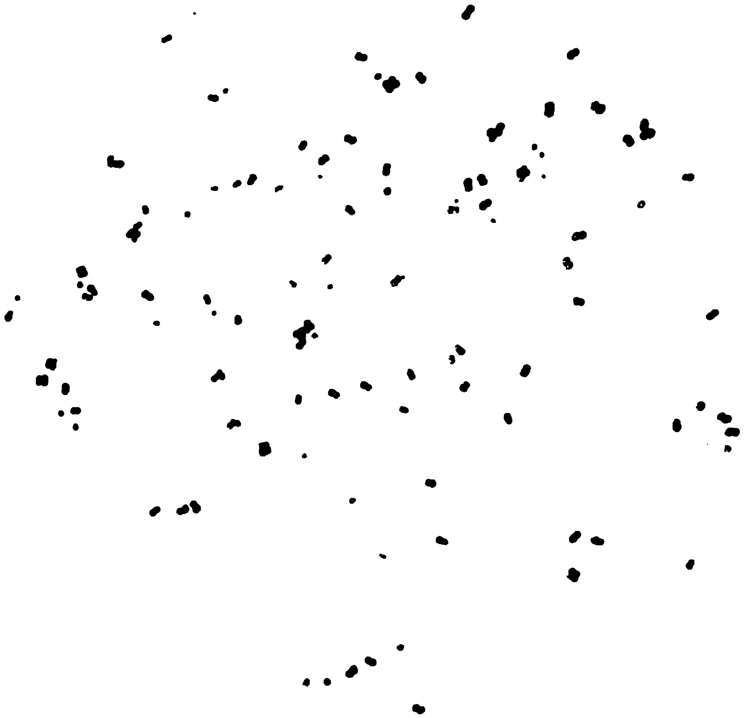
The one most severely affected was killed July 21, at which time the temperature was $104\frac{3}{5}°$ F., and there was complete loss of appetite. The point of inoculation was much swollen, the enlargement extending forward under the abdomen, and was about 6 inches in length by 2 in breadth. When cut across it was found to be dense and fibrous and creaked under the knife. A clear lymph flowed from the cut surface. In the center of the swelling was an irregular cavity, 1 to 2 inches across and partly filled with dry caseous material, reminding one of the sequestrum formed in fowl cholera when an inactive virus is injected into the muscles in large quantities. The right lung was nearly all of a deep-red color with extensive areas of infarction. There was a small quantity of effusion in the cavity of the thorax. The intestinal tract was congested but there was no peritoneal effusion.

The pleural effusion was collected in vacuum tubes with all known precautions to prevent access of atmospheric germs, and hermetically sealed. Cultivations were made by infecting sterilized nutritive liquids in the cultivation apparatus with small quantities of this pleural effusion. The cultivation liquids used were pork and beef broths which had not been neutralized and neutral veal broth. All the attempted cultivations were successful, and the organism which multiplied was of identical appearance in each—it was a diplococcus or figure eight in form, and had a tendency to adhere in short chains and small clusters.

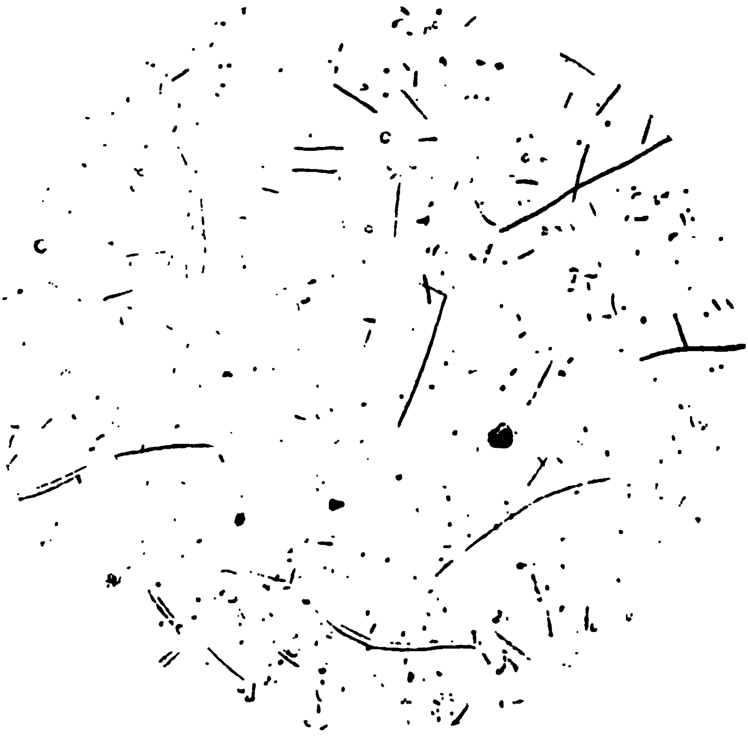
This organism was carried through three cultivations, each apparatus containing about half an ounce (15cc.) of liquid. August 2 experiment No. 3 was made by inoculating 2 pigs with the third cultivation of this micrococcus. One of these had a hypodermic injection of 4cc. and the other of 10cc. of the cultivation liquid. This was made on the inner side of both thighs and with the latter also between the fore legs.

There was swelling at the point of inoculation within twenty-four hours; but no marked increase of temperature until August 7, when it reached $105\frac{1}{5}°$ with one, and $104\frac{2}{5}°$ with the other, with impaired appetite, thirst, and shivering. Two days later the skin over the entire abdomen was wrinkled, flabby, and in places losing its epidermis. From this time they improved in general symptoms until August 17, when the one that received the larger quantity of virus and which had been most severely affected was killed for examination. At this time there was extensive desquamation of the epithelium over the abdomen; the swelling at the point of inoculation had softened and contained pus. There was swelling of the lymphatic glands of the inguinal and mesenteric regions, petechiæ of the serous membranes, and slight peritoneal effusion.

Experiment No. 4.—Three pigs, Nos. 26, 27, and 28, were inoculated June 9 with a cultivation liquid seeded from the virulent effusion of a pig that had died from the result of inoculation with a very fatal virus received from Illinois. This cultivation liquid contained only micrococci, the appearance of which are very well shown in Plate XI, which was reproduced from a photograph.



SWINE-PLAGUE MICROCOCCUS.
Photo-micrograph of cultivation liquid X 436.



SEPTIC BACTERIA.
Photo-micrograph of Peritoneal Effusion.

A Hoen & Co. Photo-Lithograph Baltimore

June 14, all had elevated temperatures varying from 104° to $105\frac{4}{5}$° F., increased thirst, tucked up abdomens, swelling at the points of inoculation, rigors, and secluded themselves in their bedding. The appetite was still fair.

June 20, there was complete loss of appetite, emaciation, and profuse diarrhea.

June 29, No. 27 died, and autopsy revealed congestion of intestines, hepatization of right lung, with abundant effusion in the pleural, pericardial, and peritoneal cavities. Inoculations with this effusion caused death of another pig July 8, after showing the well-known symptoms of swine plague.

July 3, No. 28 was found in a dying condition and was destroyed, in order to get fresh material for examination and for inoculation experiments.

July 6, No. 26 died in convulsions after having presented the characteristic symptoms of the various stages of swine plague.

The notable point in this experiment is the virulence of the cultivated virus. This virus was a pure cultivation of micrococci and produced fatal results in every case. The results of our inoculation experiments with cultivated micrococci have heretofore been more or less unsatisfactory, because, while the symptoms were those of swine plague, the disease produced did not correspond in its malignancy to the swine plague which so frequently decimates the herds of the West. In this case, however, the disease developing as a result of inoculation had all the malignancy of the most severe outbreaks which I have ever witnessed, and in subsequent experiments with virus obtained from these animals this fatal type has been retained and every animal inoculated has succumbed.

On July 3, pig No. 34 was inoculated with mixed pleural and peritoneal effusion obtained from No. 28, which was killed that day in the last stages of swine plague, produced by inoculation with cultivated virus as detailed above. July 15, the temperature was 104° F., and there were periods of shivering. From this time the progress of the attack was rapid; there was a red blush of the skin over the abdomen, diarrhea, loss of appetite, prostration, and tendency to hide in the litter. July 18, it was very much debilitated, the breathing was rapid, and it was scarcely able to walk. It would undoubtedly have died in a few hours. It was killed for examination and for pure virus.

Autopsy showed the lungs to be covered on pleural surface with petechiæ, but there was no hepatization. The inguinal and mesenteric glands were greatly enlarged and congested; the small intestines inflamed; the cæcum was the seat of three large ulcerous patches, 1 to 2 inches in diameter, and several of smaller size. These were black on the surface and on sections the tissue appeared dense, fibrous, and pale. The ileo-cæcal valve was completely covered with such an ulcer, and the mucous membrane of the stomach was much congested.

Thoroughly sterilized vacuum tubes were filled from the jugular vein, from the right ventricle, and with the pericardial and peritoneal effusion, each of which were abundant. At the time of the autopsy small quantities of each of these effusions and of the blood were dried on cover-glasses for examination in the laboratory.

The tubes of peritoneal fluid when opened emitted a very disagreeable odor of putrefaction. Stained cover-glass preparations showed that it contained both micrococci and rods. Cultures of the same contained micrococci, a bacillus with pointed ends, probably the *Bacillus butyricus*,

and a few rods of bacterium termo. From this result it becomes an interesting question to learn if these various organisms really existed in the peritoneal liquid at the time of the animal's slaughter, or if they were introduced from the atmosphere during the necessary manipulations for filling and sealing the vacuum tubes. In other words, is it possible for septic bacteria, in diseases which produce lesions of the intestines, to penetrate the walls of these organs and multiply in the peritoneal effusion before the death of the animal? In a former report (Annual Report Department of Agriculture, 1880, p. 432), I have collected a number of observations which seem to answer this question in the affirmative. Fortunately in the case under consideration examinations were made which furnish satisfactory evidence that there were various forms of bacterial organism in the fluid of the peritoneal cavity before the death of the animal. Preparations were made by thoroughly drying this fluid on cover-glasses as soon as the abdominal cavity was opened, and in these, of course, there could be no change before examination. Such preparations stained and mounted demonstrate conclusively that while the micrococci predominated, there were also present a considerable number of bacilli. These observations, which were made with the greatest precautions to avoid errors, go far to reconcile the discrepancies which have appeared to exist in the results of the various investigations of this disease.

Cover-glass preparations of blood from the jugular presented no definite bacterial forms even after staining. Cultures of this blood remained perfectly sterile.

The pericardial effusion contained large numbers of micrococci, easily seen both in unstained and stained preparations. Cultivations gave pure growths of micrococci.

The blood from right ventricle showed aggregations of micrococci, and cultures of this blood produced a pure growth of the same organism.

Sections of the cæcal ulcer contained enormous aggregations of micrococci in the depths of the cavity; the necrotic portion appeared to consist almost entirely of these bodies. In some sections small colonies of micrococci were found in the deeper parts of the tissue. No rods could be found even in sections stained with fuchsine, a stain which Klein used in his investigations.

In sections of the spleen, stained in various ways, no organism could be detected.

Sections of the most congested mesenteric gland revealed no organisms within the gland tissue, but the peritoneal surface and its serous covering were studded with micrococci, interspersed with which might be seen a considerable number of large and small rods.

Pig No. 39 was inoculated July 17, and was slaughtered August 11, being at that time very severely affected, and presenting well-marked symptoms of swine plague. The mesenteric vessels were congested, as were those about the ileo-cæcal valve, but there were no ulcerations at this point. The lungs were pale, but contained a number of dark-colored congested patches. There was no pleural effusion; the pericardial cavity contained a considerable amount of liquid, and there was also slight peritoneal effusion.

Cultures of the pericardial fluid gave a pure growth of micrococci. The vacuum tubes, filled with peritoneal fluid, were preserved until September 2, and were then found to contain large numbers of micrococci, but no other organisms.

A large number of observations similar to the above have been made, and in all cases where a pure cultivation has been obtained the organism which multiplied was a micrococcus, and when the virulence of such cultivated micrococci has been tested by inoculation experiments typical and fatal cases of swine plague have resulted.

Respectfully submitted.

D. E. SALMON, *D. V. M.*,
Chief of Bureau of Animal Industry.

SYNGAMUS TRACHEALIS.

EXPLANATION OF PLATES.

PLATE I, FIG. 1.—The trachea of an adult pheasant, whose death was caused by the gapes, slit open longitudinally, and showing, in its interior and attached to the mucous membrane, about thirty pairs of syngames in various stages of development (natural size).

FIG. 2.—A pair of syngames, attached with the mouth of the male and that of the female (enlarged 4 diameters).

FIG. 3.—A pair of syngames enlarged 10 diameters; A, male; B, female; showing the intestinal canal, the œsophagus, and the buccal capsule. In the female B may be seen, in addition, the uterus and its horns filled with ova and the ovarian tube coiled around the uterus and the intestine. In the male A the testicle is seen coiled about the digestive tube.

FIG. 4.—Mouth of a female syngame; A, seen from its face; B, from the side (enlarged 40 diameters).

FIG. 5.—Portion of the neck of a female (enlarged 25 diameters), showing at *a a* the cuticle finely striated; at *b* the subcutaneous, fusiform, muscular fibers; at *c* the œsophagus; at *d* a salivary gland; and at *e* the anterior extremity of the intestine into which the œsophagus opens, and which is seen lined with hepatic cells.

PLATE II, FIG. 6.—Reproductive organs of the female (enlarged 8 diameters); *a*, uterus; *b b*, uterine horns; *c c*, oviducts or Fallopian tubes; *d d*, ovaries.

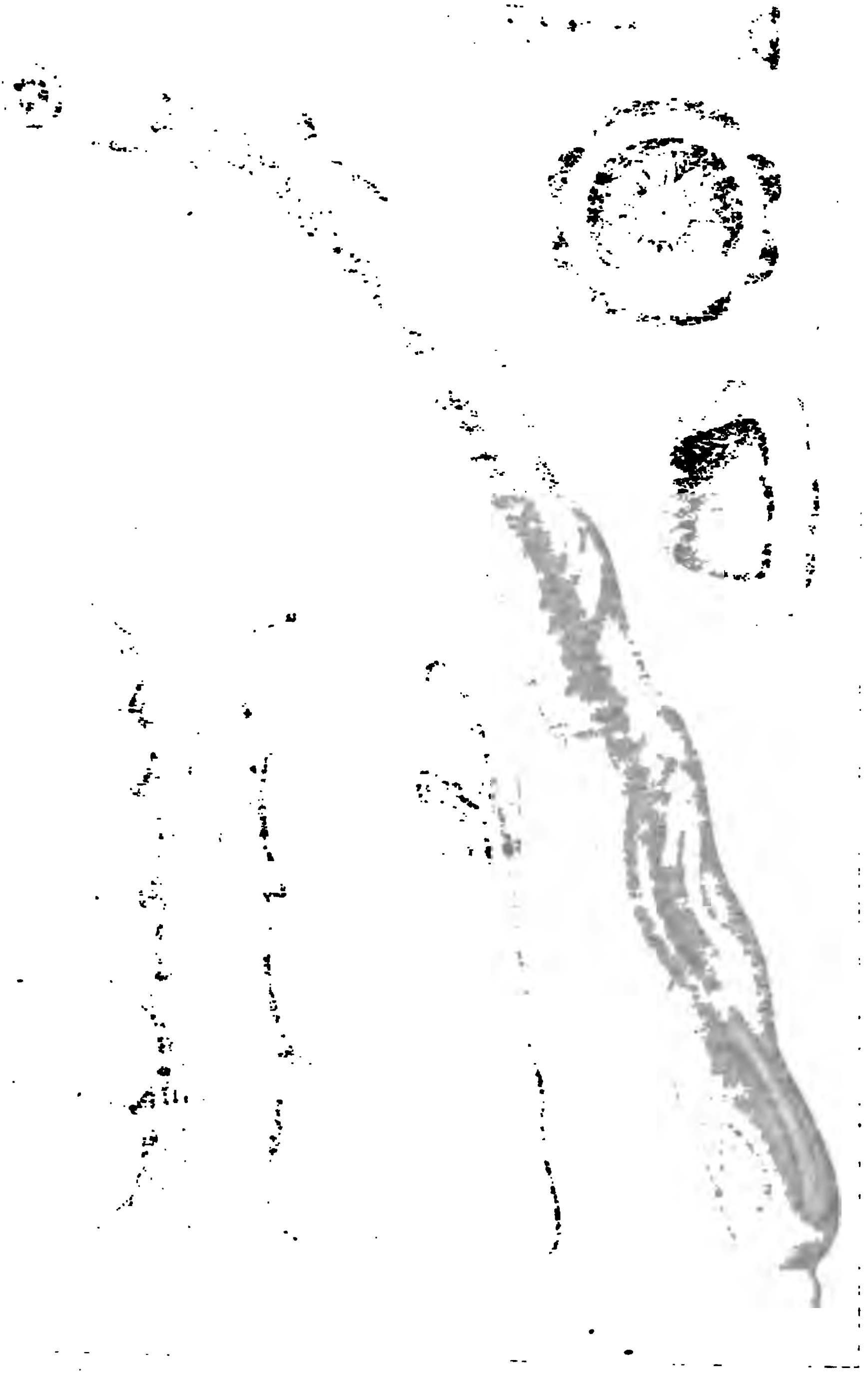
FIG. 7.—Reproductive organs of male (enlarged 20 diameters); *a*, spicules; *b*, spermatic canal; *c*, vesicula seminalis; *d*, testes.

FIG. 8.—Ova in different stages of development (enlarged 260 diameters). A, vitellus, segmented and muriform; B, ovum with granular vitellus, becoming constricted at its middle, the embryo developing laterally; C, ovum with embryo fully developed, folded like the figure 8; D, ovum with the valves at the extremities detached, and the embryo emerging.

FIG. 9.—Embryo directly after leaving the egg (enlarged 260 diameters).

FIG. 10.—Embryo somewhat older, undergoing the first molt (same enlargement).

FIG. 11.—Nymph (enlarged 100 diameters); *a*, rudiment of the genital organ.



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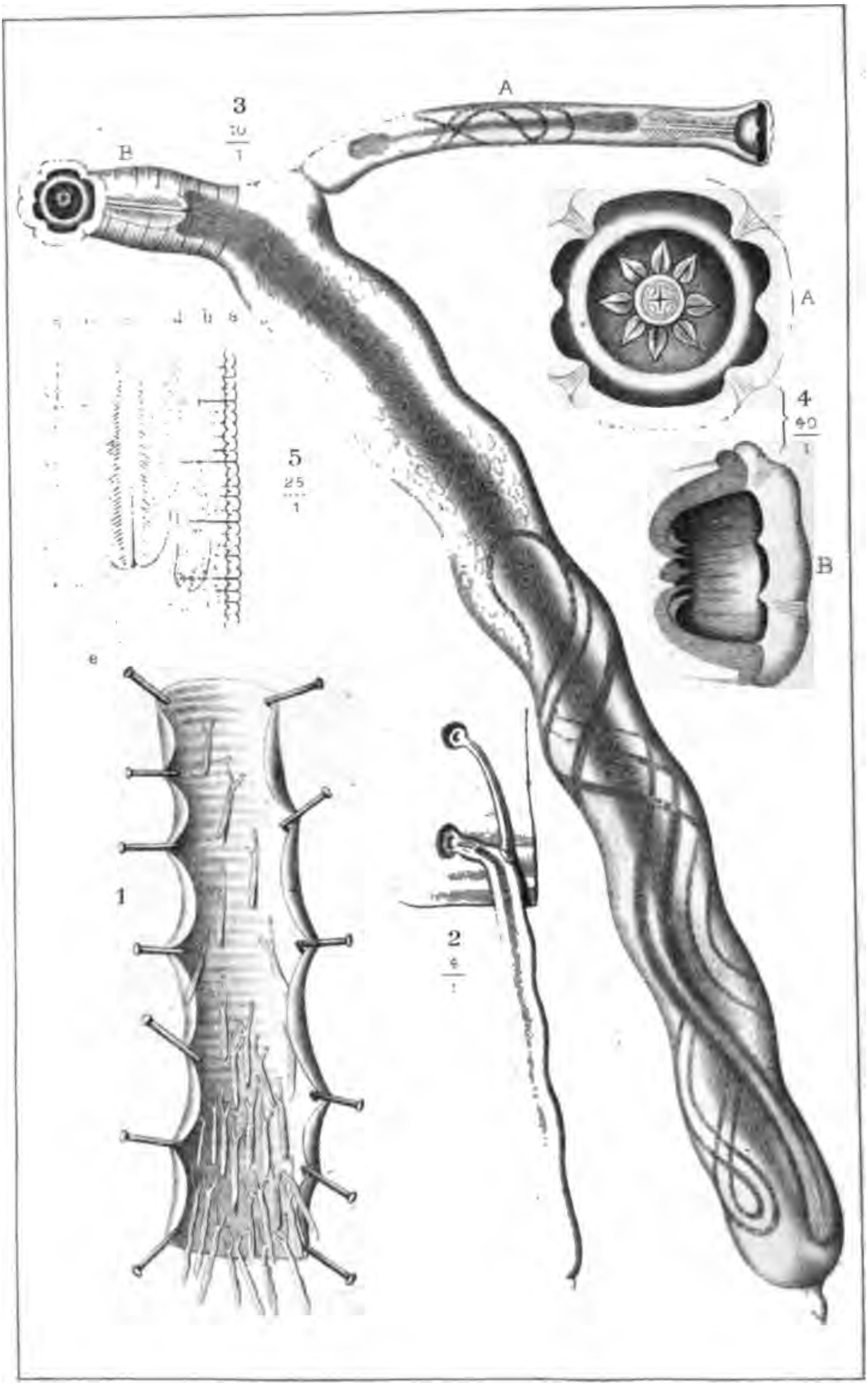
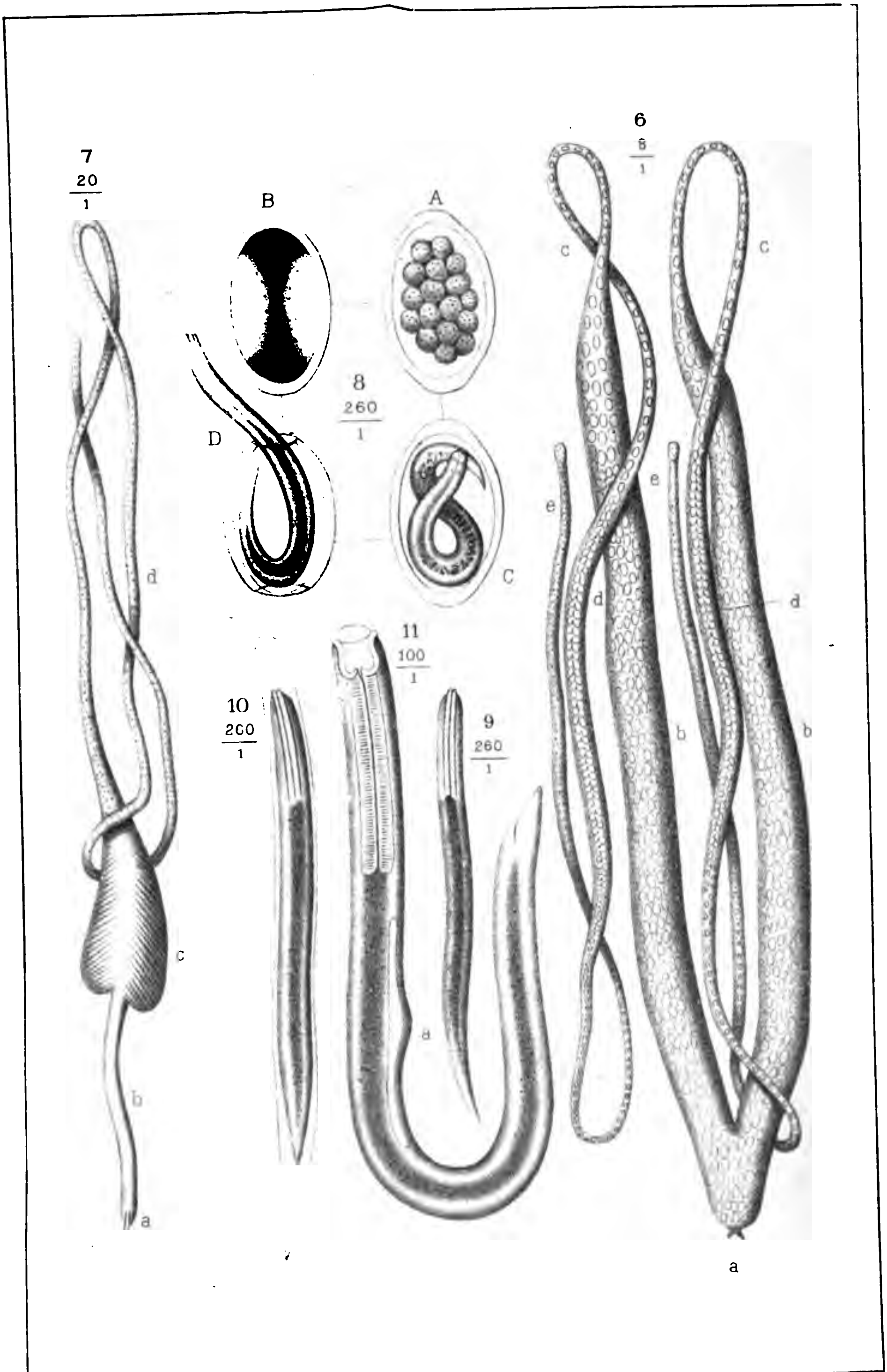


THE GAPE-WORM OF FOWLS.

Syngamus trachealis (v. Siebold) - Sclerostoma syngamus (Diesing)



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THE GAPE-WORM OF FOWLS.

Syngamus trachealis (v. Siebold) - Sclerostoma syngamus (Di

THE GAPE DISEASE OF FOWLS, AND THE PARASITE BY WHICH IT IS CAUSED.

MEMOIR ON A VERMINOUS EPIZOOTIC DISEASE OF THE PHEASANTRIES AND ON THE PARASITE WHICH CAUSES IT, THE SYNGAMUS TRACHEALIS (SIEB.), SCLEROSTOMA SYNGAMUS (DIES.), BY M. P. MEGNIN, LAUREATE OF THE INSTITUTE (ACADEMIE DES SCIENCES), MEMBER OF THE SOCIÉTÉ DE BIOLOGIE, HONORARY ASSOCIATE OF THE ROYAL VETERINARY COLLEGE OF LONDON, ETC.*

[Translated by Dr. THEOBALD SMITH.]

For several years past the pheasantries of the hunting forests of France have been ravaged by a most destructive malady, which has killed the fowls by the hundreds and even thousands. The cause is a parasite, a so-called red worm, which develops in the trachea of birds and finally suffocates them. Particularly the young subjects, from six weeks to three months of age, are apt to be the victims, although adults by no means are always spared. The chief symptoms of this affection are a suppressed or aborted cough and a characteristic gaping, whence is derived the English name "gapes." It appears to have been observed long ago in England and America, whilst with us it has not yet been studied, a fact which seems to indicate that it has been introduced from England, and that we owe its introduction to commerce by which the hunting grounds have been restocked.

I investigated this disease on the site of its activity in the inclosures of the forest of Fontainebleau in 1878 and 1879. I received many cadavers killed by the red worm from different localities of central and northern France; from the poultry-yard of Baron Rothschild, at Rambouillet, where the daily losses amounted to 1,200; from M. de Janzé, of Gournay; from the duchess de la Rochefoucault, at Montmirail; from the inclosures at Chauteau-neuf, and from various localities of Loiret and de l'Indre. Finally a dispatch, in October, 1880, informed me that the epidemic had appeared in the royal pheasantries at Turin, and was threatening to do much mischief.

This disease is not at present raging on the continent only. For ten years it has been the cause of severe losses in England. Dr. Crisp estimates that the red worm destroys annually half a million chickens, excluding pheasants and partridges, so that he says it would be of truly national importance to find the means of preventing the invasion of this red worm or of destroying it.* Furthermore, the following statement is taken from the report of the meeting of the London Entomological Society, October 1, 1879:

The president announced that Lord Walsingham, in conjunction with other gentlemen, had placed at the disposal of the council the sum of £100 to be awarded in two prizes of £50 each for the following subjects:

1. The best and most complete life history of *Sclerostoma syngamus*, supposed to produce the so-called gapes in poultry, game, and other birds.

* This monograph, finished November, 1880, has reference to the epidemics in the pheasantries of France.

2. The best and most complete life history of *Strongylus pergracilis* (Cob.), supposed to produce the grouse disease.

No life history would be considered satisfactory unless the different stages of development were observed and recorded; the competition was open to naturalists of all nationalities. Essays in English, German, or French were to be sent to the secretary of the society on or before October 15, 1882.

Although birds only are concerned in this matter, it is obvious that the economic interest involved in a solution of the questions concerning the gapes is sufficiently great. The scientific interest is no less so, because there are to be determined not only the zoological position of the worm under consideration, and its rôle in the terrible disease which destroys the gallinaceans, both domestic and wild, but also its mode of reproduction, a point hitherto entirely unknown.

This is the subject of the present memoir, a memoir in which I believe I have cleared up all the pending questions upon the zoological position of the red worm, on its anatomy and physiology, on its rôle as a cause of the gapes, finally on its embryogeny and metamorphosis, and consequently upon its mode of propagation, and upon the best means of preventing its multiplication and arresting its ravages.

HISTORICAL.

The first mention of this disease was made by Dr. Wiesenthal, who observed it in 1799, at Baltimore, Md., among hens and turkeys.† In 1806, 1807, and 1809, Georges Montagu‡ saw this epizootic among chickens in England. He believed that of all the birds of the poultry yard only the hen could be its victim, because he observed that the turkeys and ducks living with the infested hens were not attacked. He observed the same malady in young pheasants at a time when they assume the livery which distinguishes the two sexes, and in partridges whether the locality was elevated or low and humid.

Both Wiesenthal and Montagu recognized that this disease was caused by worms occupying the trachea and extending occasionally to the pharynx, but never as far as the lungs. They found as many as twenty attached to the mucous membrane, which, together with the lungs, was in an inflamed condition. These entozoa, acting finally as an obstacle to the passage of air, produced death by asphyxia.

Wiesenthal did not occupy himself with the specific determination of the worm, but Montagu regarded it as a distome, a fasciola (fluke) of a particular kind, having a round cylindrical body with two sucking disks, borne on two peduncles of unequal length.

Rudolphi* and the authors of his time continued to regard the cause of the gapes in the gallinaceans as a distome, and included it in the species *Distoma lineare* (Rud.).

Shortly after, helminthologists discovered, upon a variety of birds, a curious parasite likewise inhabiting the trachea, but this time belonging to the order of nematodes, and especially characterized by the singular habit of permanent union of the sexes. Siebold† made it the type of a new genus—the genus *Syngamus*; later, however, yielding to the observations of Nathusius, he renounced his first idea and united this helminth with the strongyli in naming it *Strongylus trachealis*.‡

After the creation of the genus *Sclerostoma* by Dujardin, in which this author unites the old strongyli possessing a mouth which is armed with

* *Path. Society of London*, October 15, 1872, and *Med. Times*, 1872, p. 471.

† *Medical and Physical Journal* (1799), II, p. 204.

‡ Account of a species of fasciola which infests the trachea of poultry, with a mode of cure, *Trans. of the Wernerian Nat. Hist. Society*, I (1811), p. 195.

a tough coriaceous capsule, Diesing placed in it the *Strongylus trachealis* of Nathusius under the name of *Sclerostoma syngamus*. Finally Dujardin § restored for this parasite the old genus *Syngamus* of Siebold, and gave it the old specific name of *Syngamus trachealis* of the same author.

Dujardin ascribes to the genus *Syngamus* the following characters:

Worms ordinarily coupled in a permanent manner or by union of the integuments; the male, cylindrical, much smaller than the irregularly cylindrical female, with constricted neck and tail tapering to a point; head globular, large, supported by an internal corneous capsule; mouth large, irregularly rounded, with six or seven broadened lobes; pharynx provided with fleshy papillæ; integument folded or wrinkled without regular striæ. The male has a truncated tail, the latter provided with a membranous expansion which fastens itself to the integument of the female. The female has the tail conical, elongated; vulva situated anteriorly at the base of the constriction forming the neck; eggs large, elliptical.

The following, according to the same author, are the characters of the only species, *Syngamus trachealis*, which this genus includes:

Body soft, colored bright red by a liquid interposed between the viscera. Male 4 to 4.5^{mm} (.157—.177 inch) long; .4^{mm} (.016 inch) wide; enlarged, obliquely truncated head about .7^{mm} (.028 inch) broad. Tail terminated obliquely by a convex, unilateral, membranous sac or bursa .25 to .3^{mm} (.009 to .012 inch) long, attached to the superior border of the vulva of the female and supported by 12 to 15 equal rays. Female 13^{mm} (.512 inch) long; .3 to 1^{mm} (.01 to .04 inch) broad, irregularly folded and wrinkled; head 1.3^{mm} (.05 inch) broad; tail resembling an elongated cone; anus 1.2^{mm} (.047 inch) from extremity; projecting vulva at the base of a neck 1.5 to 2^{mm} (.058 to .08 inch) long, inclined to one side; eggs smooth, elliptical, .087 to .093^{mm} (.0034 to .0036 inch) long, with a short terminal neck.

Dujardin found the *Syngamus trachealis* to the number of five pairs in the trachea of two magpies (*Corvus pica*) at Rennes. He was able to determine that even after maceration the male could not be separated from the female without rupture of the integuments.

This parasite has been found by Nathusius either in Germany or in England within the trachea of the following species: The swift (*Cypselus apus*), the starling (*Sturnus vulgaris*), the green woodpecker (*Picus viridis*), the pheasant cock (*Phasianus gallus*), and the black stork (*Ciconia nigra*), granting that it was the same species.

What relation exists between the two parasites of the bird's trachea spoken of above—the fasciola of Montagu, the cause of the gapes, and the *Syngamus* of Siebold?

Dujardin and Diesing regarded as entirely erroneous the classification among the distomes of the parasite found by Montagu in the trachea of birds affected with the gapes. This parasite was to them none other than the *Syngamus*, but as they did not enter into any details concerning the accidents which it is liable to produce, some doubts appear to have remained in the minds of French helminthologists concerning this assimilation. For we read in M. Davaine's treatise on Entozoa (2d ed. p. 37) the following statement concerning the parasites which cause the gapes among the Gallinae:

These entozoa, which for a long time have been referred to the distomes, are probably identical with the *Sclerostoma syngamus*, a nematode worm, to which the permanent union of male and female has given a particular physiognomy which has deceived the earlier observers.

The word "probably," in the above extract well indicates that for M. Davaine there was as yet no certainty that the gapes was caused by the *Syngamus trachealis*; there was only a probability. Moreover, in

**Synops.* pp. 414, 415.
† *Archiv f. Naturgeschichte*, Wiegmann (1835), p. 1.
‡ L. c., 1836.
§ *Histoire nat. des helminthes in suites à Buffon.* Roret, Paris, 1845, p. 260.

the latest, fullest, and most noteworthy article which has appeared in France on the subject of helminthology as applied to domestic animals,* the author, M. Baillet, without saying a single word about the terrible disease, the gapes, with which in fact he does not seem to be acquainted, limits himself to noting the existence of *Syngamus* by the following sentence:

> Before concluding the tribe of sclerostomes, we will mention the genus *Syngamus* (Siebold), a parasite of various birds which has been occasionally observed in the trachea of the cock and the hen.

This is all he says of this parasite. Up to the present, then, there have been only vague conceptions or none at all, concerning the pathogenic action of syngamus.† Even its natural history is poorly known, since in a remarkable monograph on a new nematode of the genus *Hedruris*‡ Prof. E. Perrier, citing incidently the helminths which present the peculiarity of a male united permanently to a female, says, concerning the parasite under discussion, page 6:

> Among the nematodes of the genus *Syngamus* the male lives attached to the female by means of a caudal sucking disk and *twines himself about her as does the male of Hedruis.*

This last statement italicized contains an error which proves that M. Perrier had not yet seen the syngames in the position which they occupy in the trachea, for the male is never coiled about the female, as we will show further on, and as we have enabled M. Perrier to demonstrate for himself.

We are now permitted to say, after having studied the gapes in the various pheasantries of central France, and the environments of Paris, where this terrible epizootic has claimed thousands of victims, that we know positively that the parasite which causes it, the so-called forked-worm, or red worm of the pheasant breeders, is none other than the *Syngamus trachealis*, and by no means a distome; we know that it corresponds entirely with the general characters traced by Dujardin and Cobbold, if we except a considerable number of anatomical and physiological details which we have to add or to rectify, and its migrations and habits which have thus far remained wholly undescribed. There was complete ignorance of its mode of development, reproduction, and its transmigrations. All these we have been able to follow experimentally or in the poultry-yards, and hence to deduce the most rational indications to combat the gapes successfully and to arrest its spread. Experience has fully confirmed our deductions.

ZOOLOGICAL AND ANATOMICAL DESCRIPTION.

We must, at first, rectify the diagnosis of the genus and species as given by the authors, because it appears to us faulty, especially in that which refers to the mouth-parts. We present the following diagnosis of the genus:

Mouth large, supported by a hollow, hemispherical, chitinous capsule, its background furnished with six or seven chitinous, cutting papillæ; border thick and turned back (*retroussé*), cut into six symmetrical lobes, united to the integument by its entire external face, and furnished by it with four equal membranous lips, which form a prolongation to the lobed border of the capsule. To this they are united by four bands, which

* Article *Helminthe, Dict. Vétérin.* of Bouley and Reynal, vol. III. Paris, 1866.
† According to Cobbold the *Syngamus* is the sole cause of the gapes.
‡ *Nouvelles Archives du Museum*, vol. VII., Paris, 1871.

attach the commissures of the lips to the four deeper notches between the lobes of the capsule. Female fixed by its mouth to the tracheal mucous membrane of its host; the male likewise attached by its mouth to the same mucous membrane and united immovably by its caudal bursa to the vulva of the female, around which it is soldered, as it were. The two spicules equal, contiguous, extremely fine, and very short. Ova provided with a valve at each end of the longer axis. The eel-like embryos are developed within the uterus of the female whence they emerge only at the death of the latter. Cuticle, with very delicate striæ, disappearing with age, but persisting in the cervical region.

Are there several species of *Syngamus?* Up to the present time helminthologists have agreed to admit but a single species, the *Syngamus trachealis* of Siebold; but the characters which they attribute to it differ in certain points from those of the species which we have studied as infesting the pheasants in France. Thus the latter attains twice the dimensions given by Dujardin. The head of the male, says this observer, is obliquely truncated, while in the species examined by us it is squarely terminal. The tail of the female, Dujardin continues, is an elongated cone and the anus 1.2^{mm} (.047 inch) from the extremity, while in the parasite of our pheasants the tail is either abruptly conical or rounded like a stump and pointed; in other words, it has the form of a cylindro-conical appendage, springing from the middle of the rounded posterior extremity (Plate I, Fig. 3); the anus opens at the base of this small tail, which is not more than .1 to .2^{mm} (.004 to .008 inches) long.

Unless there was some error of observation, or some typographical mistake in the figures, or unless Dujardin had not seen the highest degree of development which the syngames attain, the parasite of the pheasant would constitute a distinct species, or at least a variety.

Without wishing to decide this question, which is only possible by making a direct comparison of the individuals found on different species of birds, we shall give the diagnosis of *Syngamus trachealis* after the species or variety which infests the pheasants before offering a detailed description.

Body cylindrical, becoming with age, in the female only, more or less sinuous or torulose; colored bright red by the coloring matter of the absorbed blood which tinges the nutritive fluid interposed between the organs.

Male 2^{mm} (.079 inch) long and .2^{mm} (.0078 inch) broad at the beginning of union with the female, and reaching a length of 6^{mm} (.236 inch) and a breadth of .5^{mm} (.02 inch) at the end of ovulation. Body always cylindrical, surpassed in its diameter by that of the head by .2^{mm} to .3^{mm} (.0078—.012 inch); posterior extremity slightly club-shaped, inclined, oblique, terminated by a membranous bell-shaped sac or bursa, higher anteriorly than posteriorly, where it is cleft and notched along its entire height, supported by twelve simple rays, united to the vulva.

Female about 5^{mm} (.197 inch) long and .35^{mm} (.0137 inch) broad at the beginning of copulation, attaining a length of 20^{mm} to 22^{mm} (.787—.866 inch), and a breadth at the middle of the body of 1.1^{mm} (.043 inch) at the end of ovulation; body at first cylindrical with delicately striated integument, becoming later more or less sinuous, torulose, and smooth, the striæ persisting only in the cervical region. Head 1^{mm} (.039 inch), broad at the period of complete development, surpassing the diameter of the neck by .2^{mm} (.0078 inch), which is itself smaller by .3^{mm} (.0118 inch) than the diameter of the middle of the body. Vulva springing from the base of an inclined neck, which is 1.5^{mm} to 3^{mm} (.059—.118 inch)

long. Ova innumerable, smooth, elliptical, .085^{mm} to .09^{mm} (.0033—.0035 inch) long, and .05^{mm} (.002 inch) broad, each pole closed by a hood-like, hemispherical valve, which becomes entirely detached at the time of hatching. Embryos eel-like, developed in the body of the female, which sets them at liberty only by its death and the destruction of its body; at birth they measure .28^{mm} (.011 inch).

Habitat of the adults.—Trachea of pheasants.

We shall now study in detail the various parts of the body in the following order:

1. The general envelope of the body, consisting of the cuticle and the muscular layer lining it; 2, the digestive tube with its accessory parts; 3, the nervous system; 4, the system of excretory vessels; 5, the male and female genital apparatus as it exists in the most highly developed adults.

Body envelope.—The cuticle (Plate I, Fig. 5, *a*, *a*) is very thin, about .05^{mm} (.002 inch) thick, diaphanous, in appearance homogeneous, for we have been unable to distinguish several layers, as has been done with the larger nematodes. In young subjects it bears fine transverse striæ, but in old and united pairs of which the female is bearing eggs, and especially when these eggs contain well-developed embryos, the striæ of the trunk are completely effaced, but persist on the neck, where they can be best seen in the female, in which they are .087^{mm} (.0034 inch) apart, each fourth or fifth being deeper than the rest. Around the mouth the cuticle expands like a collar or gamopetalous corolla, with four equal rounded divisions forming four lips. At the same time it furnishes a broad margin to the thick and scalloped border of the buccal armature. In the male the cuticle goes to form the caudal, bell-shaped bursa, which is cleft posteriorly and longer anteriorly, the latter aspect being probably the true dorsal aspect of the worm. This bursa is supported by six simple rays on each side. It caps the hemispherically projecting vulva of the female and is united to it so intimately that even after the death of the worms and their maceration in water it becomes torn before it can be separated from the vulva.

The muscular layer which lines the internal surface of the cuticle forms four longitudinal bands, as among the other nematoid worms, two dorsal and two ventral, separated from each other by four linear intervals. These muscular tracts are very delicate and permit the internal organs to be seen through them. Only the superficial layer is distinguishable. It consists of longitudinal fusiform fibers (Plate I, Fig. 5, *b*) and is lined with parenchymatous cells, which may be regarded as a deeper muscular layer.

Digestive apparatus.—In the digestive tract three regions may be distinguished—the mouth, the œsophagus, and the intestine.

The mouth (Plate I, Fig. 4, *A*, *B*) opens on the anterior extremity of the body. It is surrounded by four equal symmetrical lips already described. At the four commissures of these lips may be seen four strong bands or nervures, which unite the membraneous labial circle to the coriaceous armature of the mouth. This armature, made up of brown chitine, has the form of a complete hemispherical capsule or cupule, the thick border of which is divided into symmetrical but unequal lobes. These consist of two large lateral lobes, each corresponding to a lip, two small anterior ones corresponding to the anterior lip and two small posterior corresponding to the posterior lip. At the opposite and symmetrical notches at the extremities of the large lateral lobes are inserted the bands or ligaments which separate or which unite the membranous lips. The bottom or background of the buccal cavity is a

true pharynx, to which is attached the superior end of the œsophagus. It is pierced by a round aperture opening into the œsophageal cavity. On the periphery of this opening are disposed six, sometimes seven, radiating papillæ, hard like the capsule itself, with dorsal cutting edges. They are real fixed lancets, performing a function similar to those of the surgical instrument known under the name of bdellometer of Scarlandière.

The œsophagus (Plate I, Fig. 5, *c*) is relatively short, extending from the pharynx to the middle of the neck; it is club-shaped and very thick. Its lumen appears to us tetraquetral rather than triquetral, as among other nematoid worms. In fact, the pharyngeal insertion of the tube is crucial, *i. e.*, with four, not three, branches (Plate I, Fig. 4, A). The mucous membrane is surrounded by a longitudinal muscular layer, which, in turn, is enveloped by a layer of very stout radiating fibers, longer inferiorly. The whole is inclosed in a structureless membrane.

The upper extremity of the intestine into which the œsophagus opens is very wide. It is continued by a straight, wide, cylindrical tube, lined, in its entire extent, with brownish, distinctly nucleated cells, and terminates in a short oblique rectum, having the form of an inverted cone. The anus is situated at the base of the very short tail which measures only 1. to .2^{mm} (.004—.008 inch) in length. It appears to open most commonly on the dorsal aspect, that aspect which is opposite to the inclination of the head and neck or to the vulva. This is due to the spiral twisting of the female body when the uterus is laden with eggs. The anus of the male opens near the notching of the caudal bursa posteriorly. This shows that in the male also the ventral aspect is uppermost, which in the female is indicated by the vulva. In both sexes the anus is very small; and in fact an animal food, made up of the blood of the host, ought to furnish a very small quantity of solid waste.

Nervous system.—The nervous system of *Syngamus trachealis*, like that of the larger number of the higher nematodes, consists of a flattened ganglion forming a collar about the œsophagus, and giving off four quite symmetrical cords anteriorly and four posteriorly. The former pass to the mouth parts, the latter to the digestive and reproductive organs.

Secretory apparatus.—The most eminent helminthologists, among them Bastian, Schneider, and E. Perrier, have seen in certain nematodes secretory structures composed of utricles sometimes double, provided with a canal which opens on the skin in the middle of a papilla. These structures have been observed near the posterior extremity of the body in the male, and in the region of the neck in both sexes. We have sought them without success in the *Syngamus* of the pheasants. Once, however, we saw, quite distinctly, an oblique canal opening on the skin a little below the œsophageal nervous ring and arising from a glandular mass situated in the region, where, in Plate I, Fig. 5, we have shown the position of the longitudinal fusiform muscular fibers. Along the œsophagus and under the same muscular layers there is situated an elongated club-shaped gland, which opens at the base of the pharyngeal capsule (Plate I, Fig. 5, *d*). This is a true salivary gland; its walls are lined with ovoid, doubly-nucleated cells.

Reproductive apparatus: Genital organs of the male (Plate II, Fig. 7).—In the nematodes generally the testes consist of a long tube uniformly cylindrical in its whole extent from .1 to .2^{mm} (.004—.008 inch) in diameter. In the male syngame of the pheasants it presented quite characteristic differences from the known type. It is possible to see, through the translucent tissues of the body, and still better when

the testicle has been forced out of the body of the worm, a large, abrupt expansion of the tube 1^{mm} (.04 inch) from its inferior termination. This bag-pipe-like enlargement gradually contracts anteriorly and continues as a cylindrical tube slightly narrower than at its commencement. At the middle of the worm's body it twines about the intestine, then redescends and terminates in a *cul-de-sac* near the posterior extremity. The disposition of this seminiferous tube may be better seen when, by a fortunate compression, or a patient dissection, it has been forced out of the body. The three portions of which it is composed may then be readily distinguished: the first as a vas deferens, the second as a vesicula seminalis, and the third (which coils about the intestine) as the testicle proper. The latter is filled with an opaque, amorphous substance, the contents of the vesicula seminalis and the vas deferens being likewise opaque but segmented into granular corpuscles of very varying forms, having each a nucleus of .01 to .03^{mm} (.0004—.0012 inch) in diameter. These are the spermatozoids. The vas deferens, about .075^{mm} (.003 inch) in diameter, opens at the posterior extremity of the body in the center of the caudal bursa, between two very small, short, and nearly straight spicules, the extremities of which rest immovably in the vagina of the female. The vesicula seminalis, enlarged in the form of a pear, has its walls made up of muscular fibers which are all obliquely placed and inserted into a longitudinal raphé like the barbs of a feather into the shaft. The object of this arrangement undoubtedly is to cause the expulsion of the spermatozoids and their projection into the vagina of the female, the long duration of this function requiring a special and powerful apparatus.

Female genital apparatus (Plate II, Fig. 6).—As in almost all nematodes, the female generative organs comprise a uterus with two long branches narrowing abruptly into a tubular portion, the ovary proper. We have not been able to discover a bag-pipe-like swelling near the commencement of the ovary which E. Perrier has seen in the *Hedruris armata*, and which he calls the copulation pouch (vesicula copulatrix). Neither this pouch nor anything similar to it exists in the syngame.

The vulva, as has been stated, is a small opening pierced through the summit of a hemispherical papilla which is permanently covered by the caudal bursa of the male. The vagina, the canal which penetrates the papilla, is very narrow. Lodging the spicules of the male it serves as a passage for the spermatozoids which the male pours into it during his entire adult existence. It will be readily understood that it never fulfills the function of oviduct, since the inseparable union of male and female renders the discharge of ova through the vagina impossible.

The vagina is continued into a short, enlarged uterus, about .6^{mm} (.024 inch) long and broad, which divides into two long cylindrical horns, having a diameter of .3^{mm} (.012 inch) at the base and .25^{mm} (.009 inch) at the apex. They are about three times as long as the intestine, about which they coil in the most capricious windings. The uterus and its horns are filled with ova, the development of which proceeds with the age of the worm, as we shall see further on. Each horn at its apex contracts abruptly into a short cone, and is continued by a small tube about .05^{mm} (.002 inch) in diameter, which might be likened to a Fallopian tube. After a distance of 3^{mm} (.118 inch) these tubes gradually dilate into tubes of twice their diameter, filled with spherical, granular corpuscles, compressed and crowded together in one or two rows. These are the ovules, the tubes containing them, the ovaries. As long as the uterine horns, these tubes are wound in a thousand different ways about the intestine, then contract each into a tube as narrow as the Fallopian

tubes (or oviducts), containing only amorphous matter, and lastly terminate in a *cul-de-sac* devoid of dilatation or enlargement.

Amongst the ova filling the uterus and its horns, we have determined the presence of spermatozoids closely resembling those contained in the vesicula seminalis and the vas deferens of the male, but we have not succeeded in seeing them elsewhere. We believe that the fecundation is effected in the uterine horns near the ovarian extremity upon the ovules brought there by the Fallopian tubes, since there is here no organ similar to the vesicula copulatrix, which E. Perrier has pointed out in the *Hedruris armata*.

EMBRYOGENY AND DEVELOPMENT.

It has already been stated that the narrow terminal extremity of the ovary is filled with a finely granular, amorphous, opaque, and homogeneous substance. On approaching the coiled portion of the ovary this granular matter is seen to unite into spherules, which are the ovules proper. They are ranged in a single row owing to the narrow tube, the internal diameter of which they almost fill up. In the wider portion of the ovary they range themselves in two or three rows. Near the oviduct (Fallopian tube) they first become slightly ovoid, with a long diameter of .08^{mm} (.003 inch), and they possess a distinct germinal spot and vesicle. Still without shell or distinct envelope, they are led, one by one, through the oviduct into the corresponding uterine horn, where they find themselves in contact with the spermatozoids, and where they become inclosed in a shell. When this is completed, and the egg consequently perfect, it presents the form of an ellipsoid, with a long diameter of .09^{mm} (.0035 inch) and a short one of .05^{mm} (.002 inch). The egg is not truncated nor provided with a neck at each extremity, as is the case with many nematodes. There is, on the contrary, at each pole a thickening, hemispherical externally and almost flat within (Plate II, Fig. 8, A, B, C). This is an actual cover, detaching itself completely when the embryo emerges. Only the empty ovum, therefore, is really truncated at its two extremities.

In the uterine horns the ova undergo complete segmentation. Their vitellus divides into 2, 4, 8, 16, &c., small spheres, which assume the mulberry form (Plate II, Fig. 8, A). The development proceeds in the lateral regions of the egg (Plate II, Fig. 8, B), and at its close the embryo may be seen rolled up in the form of a circle or a figure of eight. The egg is now .1^{mm} (.004 inch) long and .06^{mm} (.0024 inch) broad.

But it is not to be supposed that all the developmental phases of the ovum can be followed out in every syngame. Only in case of the largest specimens can this be done by examining successively the genital organs of the female, from the extremity of the ovaries to the body of the uterus after they have been taken from the body and well spread out. It is also possible to trace the series of successive transformations which the ovule undergoes from the embryonic to the perfect state by examining a series of females from the moment of their sexual union with the male to that of their greatest development. Thus in the syngames recently conjugated, at a time when the female is scarcely 5^{mm} (.2 inch) long, only spheroidal ovules are found in the uterus and its appendages, which are very short, but slightly developed, and not distinct from the ovaries, their diameters being the same. When the female has reached a length of 1^{cm} (.4 inch), the uterus and its horns, now quite distinct, contain eggs fully formed and inclosed in a shell, but the vitellus is not yet segmented. When the body is 15^{mm} (.59

inch) long the vitellus is already segmented, and has even passed beyond the morula stage, as many of the eggs, particularly in the body of the uterus, reveal the embryo in process of development. Finally, when a length of 20 to 22^{mm} (.787–.866 inch) has been reached, eggs containing fully formed embryos, rolled up and moving within their narrow prison, are observed in the two divisions of the uterus. At this period they may be forced out of the shell by pressure between two glass slides; the covers at the extremities detach themselves completely and the embryo emerges through either opening. When it leaves the egg spontaneously, an act we have frequently observed in the water, the cephalic extremity always emerges first.

The embryo, on leaving the egg, exactly resembles an agamous anguillula (Plate II, Fig. 8, D). It is about .28^{mm} (.011 inch) long, and has a diameter of .013^{mm} (.0005 inch) at the middle of the body. The obtuse anterior extremity reveals a punctiform mouth, opening in the middle of a papilla and continued into an œsophagus which occupies the cephalic third of the body (Plate II, Fig. 9), and whose cavity is distinguished as a very fine median line. This portion of the body is clear; the remaining two-thirds is filled with granulations or fine globules. The tail is conical and elongated.

The embryos never leave the egg within the living body of the mother, however complete the development of both may be. Only by the death of the female and the destruction of its body are the ova placed at liberty. The embryo will then emerge if the medium offers favorable conditions. These are moisture and a temperature of at least 20° C. (68° F.). These facts we have frequently demonstrated by experiment and in other ways. We have even found still attached to the trachea of pheasants destroyed by the gapes couples of dead syngames, with the soft, flaccid body of the female, 24^{mm} (.945 inch) long, opened in several places by the commencing process of maceration, through which a large number of eggs had already escaped. It still contained many of them, each inclosing a fully developed, very active embryo, but there was not a single empty egg or free embryo in the entire cadaver.

We have subjected the eggs to various conditions in order to determine those most favorable to the hatching of the young. 1. When in a dry medium, as in sand, their contents dry up more rapidly in proportion to the elevation of temperature. 2. In a moist state they preserve their vitality for months, even for a year, without any perceptible modification of their contents, if the temperature is kept below 15° C. (59° F.). Under these conditions the contents finally undergo fatty degeneration and are dissolved. 3. If, while in a humid state, the temperature be raised to 20° C. (68° F.) or better, to 25° C. (77° F.), the embryo within the egg moves and turns about and finally escapes by pushing away one of the coverlets.

The combined conditions of moisture and warmth are powerful enough to bring about the development of the embryo and its escape from the egg, in which at first no trace of it can be distinguished, and which contains only the vitellus. In the water contained in crystallizing dishes, small enough to be placed on the stage of a microscope, we have studied day by day the formation of the embryo during the month of July of this year, when the temperature maintained an average of 25° C. (77° F.). We have determined that in presence of these conditions twenty-eight to thirty days suffice for the development of the embryo and its escape from the shell.

The embryos or larvæ live in the water, where they swim about in a [illegible]entine manner like the anguillulæ (vinegar eels, &c.). At a tem-

perature of 20° or 25° C. (68°–77° F.) we have been unable to keep them alive for more than eight or ten days, whilst at a lower temperature they lived for many months, almost a year. During this time they molt, the tail becoming less elongated, and assuming the form of a short cone (Plate II, Fig. 10). When the hatching has been delayed from insufficient warmth, and the embryo finally escapes from the egg, it leaves within the shell an envelope. This fact seems to prove that the molt, which takes place normally one or two days after birth, occurs in the egg itself when birth is retarded. In the experiment-glasses larvæ with short tails were often seen moving among those with long tails. The former were simply older than the latter.

The following questions now arise: Does the larva molt a second time before assuming the adult form, and what are the ways and means employed by it to reach the only place where adult and paired syngames are found—the trachea of birds?

Some species of *Sclerostomata* presents a nymphal phase, during which the young parasite is provided with an almost complete buccal armature, and lives, rolled up and encysted beneath the mucous membrane to which it attaches itself in its adult state. Repeated investigations have failed to reveal anything analogous in the syngame of the pheasants. We have every reason to believe that the nymphal stage, no doubt very short and active, is passed in the air-sacs and pulmonary bronchi, which, as is well known, intercommunicate very largely in birds, and which the larvæ may readily reach by traversing the intestinal or œsophageal tunics after escaping from the ingested eggs. We also believe that the parasites very soon after reach the trachea, to become adult, pair, and attach themselves. The following are the facts upon which this opinion is based:

1. The larvæ of Syngamus, according to our observations, do not develop well, nor will they leave the egg and become vigorous excepting in a moist and warm medium, approaching the conditions offered by the interior of a bird's body.

2. In a young pheasant, dead from the gapes, we found in the mucus obtained by scraping the lining membrane of the œsophagus, a large number of eggs of syngames with the shell opened and abandoned by the embryo. We have preparations to demonstrate this fact.

3. In the serous fluids which lubricate the walls of the air-sacs, more particularly those in relation with the duodenum, we have found in the case of young pheasants attacked with the gapes very active larvæ, almost twice as large as those just emerging from the egg, seeking their way.

4. In the cellular peritracheal tissue, in the neighborhood of the crop of one of the young pheasants referred to above, we found, stretched out parallel to the trachea, a young female syngame, already colored red, 5^{mm} (.2 inch) long, with the mouth formed like that of the adult, and even sexually matured. We think that it was a syngame which, having been delayed in the migration, failed to reach the mucosa of the trachea in due time and now could no longer do so, because the adult structure of the mouth-parts presented an impediment to its march across the tissues.

5. In the inclosures of M. de Janzé, at Gournay (Eure), which were desolated last year by the gapes, and which have presented this year some cases of this disease, the following fact has often been observed and verified by M. de Janzé himself: The young pheasants affected with this malady frequently expel, in a fit of coughing, plump, fat syngames full of eggs. The other fowls near by consume with avidity the

worms thus ejected, which they, no doubt, regard as earth-worms, or the red larvæ of the large tipulæ which resemble them, and of which they are very fond. Two or three weeks later these young pheasants are sure to present symptoms of the malady—the slight, aborted hissing cough, which is so characteristic, and the gaping, which has gained for this disease its English name.

6. For the purpose of verifying experimentally the accuracy of the facts related above, the authenticity of which, however, did not give rise to any doubt, we fed to a female parrot, on the 7th of August, four pairs of large syngames. We had just received from Mme. de la R—— de Montmirail some young pheasants, dead from the gapes, from which we obtained an ample number of syngames; the parrot being the only subject we had for experiment at the time. On August 28 this bird began to cough and to gape. On September 10 it died, suffocated by numerous syngames which we found, at the autopsy, crowded in the trachea.

Considering the large number of eggs—several thousand—which a cadaver of the female syngame contains, and the relatively small number of parasites—about thirty or more pairs—which reach their destination, or, in other words, come to maturity, we may form an estimate of the prodigious number of larvæ which die on their way or never succeed in finding it. It is, moreover, a law of nature, especially true of parasites, that the number of eggs laid is larger in proportion as the chances of destruction during the earlier period of existence are more numerous.

The great variation in the size, and hence in the age and the degree of development, noted among the syngames attached to the trachea of a bird shows that there are ordinarily several successive infections or ingestions of eggs at intervals more or less extensive. This fact may also be due to the circumstance that the conditions favorable to the development of the parasite have not been the same for all.

The feeding of healthy pheasants upon syngames filled with eggs, which have been ejected by pheasants suffering from the gapes, is not the only means by which this disease may be propagated. The observations which we have made concerning the vitality retained by the eggs of the parasite when in a moist medium—a medium in which the embryos are born and developed if the temperature reaches a suitable height (20°–25° C.)—prove that the ingestion of water and liquid or pasty aliments, containing these embryos or eggs, furnishes two other means of infection perhaps more active than the first. In every case the only media necessary for the propagation of epidemics of the gapes are food and drink contaminated with the eggs or embryos, and the birds themselves when affected with the disease, as they are then the source of an abundant emission of eggs of the parasite. No other animated medium, neither adult insect nor larva (the larvæ of ants, for example, which are a constant element of food for young pheasants, and which have been suspected with some appearance of truth), nor any mollusk, in short, can be incriminated.

MEANS OF DESTROYING THE SYNGAME AND OF ARRESTING EPIDEMICS OF THE GAPES.

The disasters caused by the parasite above described in the parks devoted to the rearing of pheasants, point out the extreme importance of finding rapid and effective means of arresting the spread of this destructive worm.

A remedy, common in England, consists in mixing the grains which are to be fed to the diseased birds with urine instead of water. Montagu, who tried this remedy without having any faith in its efficacy, was surprised at the success which he achieved, and which proved to him that it was not without utility. It is probable that the ammoniacal emanations arising from the urine are poisonous to the red worm or its embryos.

Wiesenthal relates that in America a hen's feather is stripped of its barbs to near the point, introduced into the trachea and rotated like a brush to detach the worms. We strongly question the efficiency of this practice; in the first place, because we know from experience that the worms are too firmly attached to be removed by the friction of the barbs of a feather. Should they be detached, however, they would only be pushed to the root of the trachea, where, forming a ball, they would augment the obstruction in the tube and thus bring about more promptly the death of the bird. On the other hand, the diameter of the trachea of a young pheasant from five to six weeks old, being scarcely equal to that of the shaft of a hen's feather, will not permit the introduction of the latter. Cobbold,* on the contrary, believes in the efficiency of this method, and adds that this efficiency may be increased by impregnating the feather with a germicide substance. Bartlett, who used salt for this end, or a weak infusion of tobacco, informed him that the essence of turpentine also had given excellent results. Cobbold adds with reason, that unless great care be exercised with this method the birds may be seriously injured.†

These means, at once mechanical and medicinal, have been suggested several times and varied in different ways. One of our correspondents informed us that he had cured pheasants of the red worm by removing the parasites with a small rod and pouring into the mouth of the birds a few drops of Fowler's solution. Another pretends to have removed the parasites with a piece of copper wire, which had one end curved like a handle and dipped into *oleum hypericum* (red oil). We do not doubt that they could have succeeded in thus removing red worms lodged in the pharynx, but we do not believe that they could have extracted worms by this method from the root of the trachea near the bifurcation of the bronchi, where they are most frequently lodged; for it is actually impossible to employ a rod, and above all, a metallic wire curved into a hook, as it would undoubtedly tear the trachea. The fact that young pheasants, and more frequently adults, sometimes recover spontaneously from the gapes, may have given rise to their apparent success. This happens when they are affected by only a small number of parasites, which may go through the phases of their development to their death without producing suffocation. This is the only mode of

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* *Parasites:* London, 1879; p. 445.

† Cobbold's exact words concerning this method are as follows (*loc cit*):

"First. The simplest plan consists, as Dr. Wiesenthal long ago pointed out, in stripping a feather from the tube to near the narrow end of the shaft, leaving only a few uninjured webs at the tip. The bird being secured, the webbed extremity of the feather is introduced into the windpipe. It is then twisted round a few times and withdrawn, when the worms are found attached. In some instances this plan succeeds entirely.

"Secondly. The above method is rendered more effectual when the feather is previously steeped in some medicated solution which will destroy the worms. Mr. Bartlett employs salt for this purpose, or a weak infusion of tobacco; and he informs me that the simple application of turpentine externally is sufficient to kill the worms. It should be borne in mind that the bird itself may be injuriously affected by these drugs if they are carelessly employed." Note that the turpentine is to be used externally.—TRANSR.

fatal termination, and it requires a certain number of parasites, from twenty to thirty couples for adult, and from five to ten for young pheasants. In these cases the disease is cured in spite of, and not because of, a certain mode of treatment.

One of the most rational methods of treatment has been pointed out by Montagu, who did not stop with the common method above mentioned, but who obtained much success with the following means combined: Removal from the infected places, complete replacement of the former aliments by new ones, in which hemp-seed and fresh grass figure prominently; finally, for drink, an infusion of rue (ruta) and garlic, instead of ordinary water.

The efficacy of the garlic was demonstrated to us under the following circumstances: The pheasantry in the forest of Fontainebleau was laid waste by the gapes in 1877 and 1878. This malady, which we studied on the site of its activity, was arrested and completely driven out by feeding the pheasants with a mixture consisting of hard-boiled eggs, boiled beef's heart, the crumbs of stale bread, and salad. These ingredients were chopped, pounded, and thoroughly mixed so as to make a paste. To this paste was added pounded garlic in the proportion of one clove or bulb to ten pheasants each day, the garlic being thoroughly distributed through the paste. This mixture was relished very much. Great care was bestowed upon the drinking vessels; the very pure water used was renewed twice a day. The same treatment was successful in the several inclosures belonging to the country-seats in the neighborhood of Fontainebleau and Melun. A large number of correspondents to whom we suggested it were fully satisfied in having applied it. We also learned that the pheasants occasionally refused the garlic, and one of our correspondents informed us that he had succeeded in making them take it by preparing a real garlic salad; for he had accidentally observed how the animals which had refused the garlic paste cast themselves voraciously upon a garlic salad which was not intended for them.

We can readily explain the virtue of garlic, known from time immemorial as an excellent anthelmintic, as it is volatile and is eliminated by the respiratory passages, reaching, in this way, the trachea, where the syngames are lodged. The proof that the essential and volatile principles of garlic are eliminated by the lungs is daily furnished by those persons who, like the inhabitants of the south of France, are fond of this condiment. The odor of their breath betrays them immediately.

Besides garlic, we have experimented with another substance, which, like the former, has the advantage of being a strong-smelling vermifuge and more stupefying than ether (which might also be employed), properties which enhance its parasiticide powers. We refer to assafœtida, which we have used as a powder with an equal part of yellow pulverized gentian, mixed with the paste which is fed to the pheasants, in the proportion of 50 centigrams (about 7½ grains) per head each day. As a complement to this treatment we have added to each liter (or quart) of drinking water the following solution: Salicylic acid, 1 gram (about 15½ grains); distilled water, 100 grams (about 3½ fluid ounces).

The use of the salicylic acid, the toxic power of which upon the embryos of syngames we have recognized experimentally, had for its sole object the destruction of those embryos which might be present in the drinking water of the young pheasants.

This treatment we have employed in the parks of Baron Rothschild, at Rambouillet, which were ravaged by the gapes in a manner so disastrous that up to 1,200 young pheasants were found dead each morn-

ing. A letter from the baron's steward, dated September 7, 1879, testifies that the treatment has fully succeeded in arresting, in a few days even, the epidemic.

We will conclude these suggestions by stating that it is alway beneficial and even indispensable to disinfect the soil of the inclosures after having transferred the young pheasants to a virgin soil. One of the best means of destroying the eggs and embryos which may possibly exist on the soil of the contaminated inclosures, consists in sprinking it with water containing in solution a sufficiently large quantity of salicylic or sulphuric acid, one gram (15½ grains) to a liter (about 1 quart) for example.

Great care should also be taken to isolate the sick birds on the first appearance of the symptoms of the disease, and to keep them closely confined till complete and well-confirmed recovery. The cadavers of dead birds must be buried deep, or it were even better to burn them.

SUPPLEMENT.

In the investigations which we have made concerning the development of *Syngamus trachealis*, and which are reported in the preceding memoir, written about twenty months ago, we pointed out that the eggs ejected during the coughing fits hatch in the water, and that the embryo, resembling an anguillula, may live in this medium for many months, because we have kept some alive almost a year in a low temperature. The birds are infected by drinking the water containing these embryos. But how are they developed in the body of birds, and in what way do they reach the trachea, where they are found, in the adult state, fixed to the mucous membrane like leeches, the two sexes united in a permanent manner and the females crowded with eggs?

In the preceding memoir we stated that we had every reason to believe that the nymphal phase, unknown to us, was passed in the air-sacs and bronchi, and that later on the worm reached the trachea where it became adult. We offered as a proof of this hypothesis the discovery of embryos of syngames, in every respect similar to those which we had obtained from the hatching of ova, in the air-sacs of several young pheasants killed by the gapes.

There was, therefore, only a presumption, well founded, it is true, of the existence of the nymphs in the bronchi of the pheasants. At present it is no longer a presumption but a certainty. At the autopsies, lately made, of two red partridges, killed by syngames, we met the nymphal form in the pulmonary tissue itself, rolled up in the bronchial dilatations. (Plate II, Fig. 11.) It is cylindrical, very elongated, about 1.6 to 2^{mm}. (.063 to .079 inch) long, and .04 ^{mm}. (.0016 inch) in diameter. It is, consequently, ten times as large as the embryo when it leaves the egg, and one-tenth as large as the adult worm at the period of its greatest development. The armature of the mouth is already cupulate or cup-shaped, but still without color, border, and lobes. The muscular œsophagus is very long and cylindrical. The intestine, which extends in a straight line from the termination of the œsophagus to the anus, fills almost the entire body, and is already colored red; near the anterior third of the body may be seen a fleshy thickening, which sends a prolongation forward beyond the posterior extremity of the œsophagus, and one, longer than the first, backward toward the caudal extremity. This is the rudiment of the sexual organ.

This discovery of the nymph enables us to say that all the developmental phases of *Syngamus trachealis* are now known. The only two media which this parasite inhabits during its entire existence are the water or moist earth during its embryonal condition, and the respiratory organs of its victim during its nymphal and its adult phase. It is, therefore, developed without the aid of any other medium than the water, corresponding in this respect to the immense majority of verminous parasites.

REPORT OF THE ENTOMOLOGIST.

INTRODUCTION.

SIR: I have the honor to present herewith my annual report, together with some account of the work done by the Bureau of Entomology. The report contains articles on several of the insects that have attracted unusual attention during the year. The leading article is on the insects injuriously affecting the Cabbage, being the continuation and completion of that in my last report on "Cabbage Worms." That article treated of ten larvæ which were more or less perfectly amenable to similar remedial treatment, while the present article adds twenty-one other insects belonging to five Orders and requiring different treatment. Thus there are thirty-one species known to be quite destructive to Cabbage, and this list does not include several other species occasionally found upon leaf and root, but not specially injurious. It is interesting to note the correspondence, as set forth in the report, between the insects which attack the plant in America and Europe, for there are at least nine species common to both countries, while six others have generic representatives that work in a similar manner and that are in some instances so closely allied, specifically, as to be scarcely distinguishable. Most, if not all, of those which are identical have been imported to America from the trans-Atlantic.

In this connection it affords me pleasure to announce the successful introduction of one of the most common and useful of the parasites of cabbage worms in Europe, viz., *Apanteles glomeratus*, the facts in reference to which are recorded in the report.

I have reproduced some remarks made at the annual meeting of the Georgia State Agricultural Society last February on "General Truths in applied Entomology," believing them to be sufficiently germane, and have given some words of caution and advice as to the use of petroleum or kerosene emulsions. Since I first advocated their use in the reports from this Bureau, and since Mr. Hubbard found them, in experience, to transcend in value all other insecticides against scale-insects and other insects injurious to the Orange, these kerosene emulsions have been very generally tried and have had more prominent place than any other insecticide in the columns of the agricultural and horticultural journals of the country and in the reports of directors of different agricultural experiment stations. The literature of the subject shows that the proper methods of making and using them are so often imperfectly understood that I have deemed the reiteration of the essential facts necessary.

The year, on account of the severe winter, the exceptionally wet and cool early summer, and the protracted drought later, has been what insect collectors call a bad year, *i. e.*, most insects have been scarce; yet it has been marked by the appearance of a few in exceptionally injurious numbers, and some of these, like the Buffalo-gnat, the Streaked cottonwood leaf-beetle, and the Cottony maple-scale, are treated of in the report.

In the matter of silk-culture the Bureau has continued, as heretofore since my charge of it, to aid the industry by the dissemination of eggs and correct information to applicants from all parts of the country. The interest in the subject has been even greater than in former years, and this is essentially true of California, where the substantial encouragement of the State board of Silk-culture and of the State legislature, referred to in my last annual report, have borne fruit. Considerable correspondence was had, particularly with Dr. C. A. Buckbee, the president of said State board, in reference to Congressional aid by special bill or otherwise, and an appropriation of $15,000 was made by Congress for the encouragement and development of the industry. With this increased means the Bureau will accomplish whatever can be accomplished to further the industry, and a special division of silk-culture has been established, with Mr. Philip Walker in charge. Mr. Walker is well equipped for the work, having had an extensive experience in France and being enthusiastic in his faith as to the future of the industry in the United States. I find no reason to change the views expressed on this subject in previous reports and in my Manual, whether as to the danger of overstimulating the inexperienced by monetary inducement in the shape of bounty, or as to the ultimate need of a protective duty on the reeled silk to give silk-production here any permanent and profitable footing on a sufficiently extensive scale. History shows that the former methods have had but a transient influence that necessarily involves reaction, whereas the latter is permanent in its benefits and in accordance with the prevailing protective sentiment of the country. Yet silk-culture, by its peculiarities, offers to a large class employment which they could not otherwise get, and will always attract attention, even though the profit be trifling; and between extreme optimism on the one side as illustrated by Mr. Buckbee's argument in memorials to Congress, and extreme pessimism on the other as illustrated by a published reply thereto, by Mr. John D. Cutter, of New York, there is a moderate ground which should be carefully cultivated. For fifteen years, now, I have carefully watched all that has been done, and have, in my feeble way, aided to promote the industry, and have seen one effort after another to establish it on anything like an extensive scale fail, and always for the reason that capital and ordinary labor can find more profitable employment. In studying the status of the industry in South France the past summer I was also surprised to find it languishing, and, as Professor Maillot, who has charge of the sericicultural station at Montpellier, assured me, for the same reason that it has hitherto failed with us, viz: Inability to compete with the silk produced by the cheaper labor of other countries and especially of China and Japan. If the French silk-grower cannot well cope with this competition, with the price of ordinary labor at 3 francs for men and 1½ francs for women, how can we expect to! The chief hope, in addition to the advantages we possess as indicated in the preface in the second edition of my Manual, is in the Serrel reeling-machine, which, if it fulfills its present promises, will revolutionize the silk industry and greatly subordinate the question of labor. It is in this direction, then, that there is hope, and fuller consideration of it will be found in the report.

The field force of the Bureau is the same as a year ago, with the addition of Mr. F. M. Webster, who is stationed at La Fayette, Ind., and who has been charged with the study of yet needed facts in connection with the insects affecting our grain crops. As will appear from the context, he has enabled me to prove beyond peradventure the phytophagic nature of the Joint-worms (genus *Isosoma*) affecting wheat and small grains, and thus still more fully to settle a question which

has been in constant dispute and which has impo. economic bearings.

Mr. H. G. Hubbard, though suffering much from ma common in Florida, has continued the work on insects a ange, and I have included a valuable article from him on t treatment of the so-called orange rust, which so disfigures ates the market value of the Florida oranges. The accurac servations I have, in many cases, been able to verify persona

Dr. A. S. Packard has continued the special work he has gaged on and contributes the results of further investigations a cause of death of evergreens and other forest trees in Northern England and New York.

Mr. J. B. Smith has worked out the hitherto unknown life-history the worm that so seriously affects the fruit of the Cranberry and whi proves to be an undescribed species of *Acrobasis*, closely allied to the Rascal Leaf-crumpler of the Apple, and which I have named *vaccinii*. He reports that the efforts of the cranberry-growers to protect the crops from its numerous enemies have been more successful than formerly, since the publication of his report upon them, the agent being water, where available, and, where not, the kerosene emulsion and London purple. Experiments which I desired as to the influence on the dimorphism of the Cranberry Teras, as also on the hibernation and summer migration of the Hop plant-louse, were unsuccessful.

Mr. Lawrence Bruner has been engaged at West Point, Nebr., in the further study of locusts. He reports a few of the genuine Rocky Mountain locust in that State, but from the data which he has been able to collect believes that no danger threatens, during the coming season of 1885, the farmers of that portion of the Mississippi Valley known as the Temporary Region, and which the species temporarily invades.

I hope soon to see the day when the appropriation for the work of this Bureau will be sufficiently increased to permit the employment of field agents in every State in which agronomic interests predominate; for, aside from the fact that the surroundings of Washington City and the insufficient conveniences in the Department buildings do not permit of much satisfactory field work and experiment, the insects peculiar to different sections of the country, affecting particular crops, can only be advantageously studied in such sections or where such crops are most at home. Such field agents should work, as far as possible, in co-operation with, or at least not in conflict with, whomever in the State may be engaged in similar work.

The office force of the Bureau has remained unchanged, and with each year becomes more proficient in the special work assigned to each individual member. An ever increasing correspondence has absorbed the chief time of myself and principal assistants, though a number of experiments have been carried on and a large number of biographic facts recorded.

Under your instructions I made a trip to Europe during the summer, sailing the latter part of May and returning the first of September. This was the first time since my connection with the Department that I have been absent any length of time, and Mr. L. O. Howard acted as assistant in charge during my absence, and deserves my thanks for the efficient manner in which he attended to the correspondence and for the assistance he has rendered in the preparation of this report.

I visited the International Forestry Exhibition at Edinburgh; made many necessary notes from the chief insect collections in England and France; took steps looking to assistance in the introduction of beneficial insects; studied certain questions bearing on silk-culture, and, at the invitation of the French minister of agriculture, spent some time in

South France in study of the present status of the American grape-vines and of the Grape Phylloxera. The proposed Phylloxera congress that I had hoped to attend at Turin on the 8th of August was postponed on account of the cholera, and for the same reason I was unable to accept an invitation from the minister of agriculture of Italy to visit that country. The use of the kerosene emulsion as a remedy against the Phylloxera was demonstrated at Montpellier, where it was favorably received, and will have full trial; and I desire here to express my sincere thanks to the many persons connected with the ministry at Paris and with the experimental schools of silk-culture, grape-culture, and general agriculture at Montpellier, for the great courtesy shown to me as a representative of the Department and for the appreciation shown for some of the practical results of late years obtained in the work of this Bureau.

Considerable time has been occupied in the preparation of a full exhibit of economic entomology to form part of the Department exhibit at the World's Industrial and Cotton Exposition at New Orleans. With the aid of material from my private collection, I have been able to prepare 32 drawers (each 24 by 30) of specimens arranged according to the different crops of the country, and giving in connection with each insect the popular and scientific name, the remedies, references to the chief articles in popular reports that treat of it, and finally its chief natural enemies. The exhibit includes, further, collections of insecticides, of insecticide machinery and appliances, and special collections illustrative of silk-culture and bee-culture. Mr. Samuel Henshaw, of Boston, who was engaged to assist in the preparation of this exhibit, and Prof. A. J. Cook, of the Michigan Agricultural College, who aided in the apicultural portion, deserve my sincere acknowledgments. A catalogue of the exhibit has also been prepared and printed.

The third report of the United States Entomological Commission—a volume of some 450 pages, and illustrated with wood-cuts, maps, and 62 plates—was distributed early in the year, and the fourth report is nearly all in type. A new edition of the Manual on Silk-culture has been issued, and Bulletins 3 and 4, containing reports and observations in the practical work of the Bureau, have been published. It is my intention and desire to have all the special reports already ordered by Congress, viz., the Bibliography of Economic Entomology, the Report on Forest Tree Insects, and that on Orange Insects published before the end of the present fiscal year.

A report on insecticides and several comprehensive monographs of families of insects, of especial economic interest, are in preparation, with no prospect of their being printed except by aid of Congress.

In conclusion, I cannot forbear to mention that the work of the Bureau has outgrown its present means of putting results before the public and its present accommodations. In addition to the annual report and the special bulletins, it would greatly augment its usefulness to have means to issue a monthly or periodical bulletin and more elaborate quarto monographs, while there is pressing need of more room for the library, the collections, the laboratory, and the workers; and I would earnestly commend these facts to your consideration.

The illustrations to the report, where not otherwise credited, have been drawn by Miss Lillie Sullivan, under my immediate supervision.

Respectfully submitted, November 3, 1884.

C. V. RILEY,
Entomologist.

Hon. GEO. B. LORING,
Commissioner of Agriculture.

CABBAGE INSECTS.

In our last annual report we published an article upon Cabbage Worms, taking up in succession all the Lepidopterous larvæ which have come into prominence as destroyers of Cabbage, and which, from their habits, are subject to the same or similar remedial measures. From these the cut-worms were necessarily excluded on account of their different feeding habits, and they will be considered in this article in connection with the principal cabbage insects belonging to other orders.

CABBAGE CUT-WORMS.

Order LEPIDOPTERA; family NOCTUIDÆ.

There are a number of species usually concerned in the work which the truck farmer generally puts to the account of "the cut-worm." The habits of all are in most respects similar, and we can best treat of them all under one head, giving the general habits and characters which will answer for all, and afterward considering each species separately.

The common cut-worms are all larvæ of Noctuid moths, and principally of the genera *Agrotis*, *Hadena*, and *Mamestra*. They are, as a rule, stout, naked worms of somber colors, curling into a roll when disturbed, and transforming to naked pupæ under ground. The moths, in general colors, are as somber as their larvæ, but the softness of the tints and the delicacy of the shading render them fully as beautiful as more highly-colored species. They fly only by night or at dusk, unless startled from their retreats at the roots of grass tufts or other secluded spots, when they fly for a short distance with a quick, darting motion, and then seek shelter. It is generally stated, following Harris, that they lay their eggs usually, in the Northern States, from the middle to the close of summer, attaching them generally to some substance near the ground. While this statement is broad enough to include, doubtless, more or less truth, yet it nevertheless remains true that in cases where actual observations have been made, the eggs have been laid on the twigs and branches of shrubs or trees, away from the herbaceous food of the young larvæ which thus are obliged to seek it as the necessary first act of their lives. The young worms hatch out and feed unnoticed upon the superabundant vegetation, and, so far as they have been traced, the first larval stages differ from the later chiefly in the front pair of prolegs being atrophied so as to cause the worms to loop in walking as do the Geometers. At the approach of winter they are usually from half to full grown, and seek hibernacula under stones and logs, or burrow beneath the surface of the ground. From these winter-quarters they come forth on the approach of spring with ravenous appetites and work great injury to many young and tender plants, not contenting themselves with feeding upon the leaves, but cutting off the plants at the stem. Many of them feed by day as well as by night, pulling into their underground burrows leaves and sprouts, and there devouring these at their leisure. The pupa state lasts from three to four weeks. Many of the species are single-brooded even as far south as Missouri, but others have two annual generations. Notwithstanding the hiding propensities of the larvæ they are, nevertheless, subject

to the attacks of parasites, especially Tachinid-flies and Ichneumonids of the genus *Ophion* and allies.

Young cabbage-plants often suffer severely from cut-worms, and there are one or two species—notably *Mamestra chenopodii*—which badly damage the old plant by eating the leaves and boring into the head. All or nearly all of the principal cut-worms will undoubtedly feed upon cabbage, but we shall here consider only those concerning which we have absolute knowledge of their cabbage-feeding proclivities. The subject of remedies will be taken up at the close of the consideration of the different species.

THE DARK-SIDED CUT-WORM.

(Larva of *Agrotis messoria* Harr.)

[Plate II; Fig. 6.]

This insect was first described by us in the *Prairie Farmer* of June 22, 1867, and subsequently treated of in our first report on the insects of Missouri (p. 74) as *Agrotis cochranii*, out of compliment to Mr. J. W. Cochran, of Calumet, Ill., who had made a number of interesting observations on this and other climbing cut-worms. Later, however, in examining his types in the collection of the Boston Society of Natural History, we found it to be a synonym of Harris's *Agrotis messoria*.

Evidently an indigene of North America, *Agrotis messoria* is widespread in the United States. It is very common in California, one of the commonest of the climbing and garden cut-worms in Missouri, is abundant throughout Illinois, Indiana, and Michigan, was first described from Massachusetts, and doubtless occurs throughout the States. It is found in Ontario and Quebec, though not commonly in the last-named Province.

While commonly found in the vegetable gardens of the Western and Northern States, this cut-worm has gained its reputation chiefly as a climber, and as injuring dwarf fruit trees. We have considered it at length in this connection in the report just referred to. It seems by preference to gut the blossom buds of dwarf fruit trees, and when these are all gone it takes the leaf buds until every bud upon the tree is destroyed. Seventy-five of these worms have been taken from a single six-year-old fruit tree on a single night, and nearly as many more found the ensuing night. Mr. Cochran says: "There is not an orchard upon the sands of Michigan or the light timber openings of Indiana, or the sandy ridges of our own State (Illinois), but that has suffered greatly, many of them entirely ruined by its depredations. It is far more destructive to fruit trees than any other insect, infinitely more so than the Canker-worm, but unlike the other depredators of our orchard trees it is easily kept in check, and at small expense permanently eradicated."

The natural history of this species is that normal to the group. It is single brooded, the larvæ hibernate, and the moths appear in July and August, after a duration in the pupa state of a month or more.

The larva (Plate II, Fig. 6, *a*) is somewhat more than an inch in length, of a dingy, ash-gray color, with lighter or darker markings. The back is light, and the sides are darker, and the customary warts are shining black. The head and thoracic plate are of a shining, ash-gray color, and the under surface of the body a dirty yellowish green.

The moth is marked as shown in the plate, the colors being: Fore-wings of a light, warm cinereous, shaded with vandyke brown and umber, the terminal space, except at apex, being darker and smoky; hind-

wings whitish, with a darker shade along the posterior border. Detailed descriptions of the earlier states are given in the original articles already alluded to. The eggs are, so far, unknown.

THE GRANULATED CUT-WORM.

(Larva of *Agrotis annexa* Treitschke.)

[Plate II; Fig. 1.]

This species is perhaps the most prominent of the cut-worms which have been sent to the Department. The moth is an old and well-known species, originally described by Treitschke in 1825, and successively treated by Boisduval, Stephens, and Guenée. It is given by the latter author as a common North American species. In the British Museum Catalogue it is entered from the United States, East Florida, St. Domingo, Jamaica, and Port Natal, while Guenée gives it as "rare au Brésil."

Concerning the larval habits, Guenée says:

The larva lives in the spring upon almost all garden vegetables, such as peas and beans; but it is especially the cereals which it attacks, and in certain years it occasions considerable loss to wheat, particularly in Virginia. It buries itself during the day in a cavity at the roots, and issues only at night to feed. Its habits, therefore, are the same as those of almost all Agrotids. But what is exceptional is that it also injures trees, for it devours the leaves of the cotton-plant, and sometimes does great damage. It pupates under ground the middle of May, and the moth issues about the first of June.

The species has a wide distribution in the United States. It is found from New York west to the Mississippi and south to Florida and Alabama. It is probably the most common of the species which were collectively designated by Glover, and are still known by Southern planters as "the cotton cut-worm," cutting off the young plants soon after they appear above the surface of the ground. The species is a general feeder, as we have found it feeding upon grass, clover, plantain, dandelion, cabbage, cotton, and many other plants. Prof. S. A. Forbes sent us specimens in April, 1882, with the statement that they had seriously injured cabbage-plants in the vicinity of Normal, Ill.

In the Northern States there is probably but one generation in a season, but in Georgia and other Southern States the worms may be found at almost any time of the year in almost any stage of growth, so that it is difficult to determine the number of broods without an extensive rearing of individuals. There are probably, however, at least three annual generations in Georgia. They pass the winter, so far as we have observed, in the larva state, retiring under sticks or stones during the cold weather. This is the worm to which we refer presently in the passage on remedies for Cabbage cut-worms, as having been trapped in such enormous numbers by Dr. A. Oemler, of Savannah, Ga.

The larva (Plate II, Fig. 1, *a*) is of a dull gray color, and may be easily recognized by what we have indicated in the popular name as its *granulate* appearance. The whole body, when viewed with a strong lens, is closely covered with very small, round, blackish granules, each bearing a minute sharp point.

The general color of the body and front wings of the moth (Plate II, Fig. 1, *h*) is dirty yellowish gray. The front wings are marked with black, as shown in the figure. The hind wings are pure white and slightly iridescent, with faint brown shades at tips. Among upward of fifty specimens which we have reared from the larva the variation is not very marked, though some are much darker than others.

In the warm fall and winter of 1882–'83 a moth of this species oviposited October 16, the eggs hatched October 27, and the larvæ had reached full growth and begun transforming December 15, the first moth issuing December 29.

The eggs of this species, which we have obtained in our vivaria, are laid in autumn, and were scattered irregularly and singly on grass, a habit which is exceptional and probably abnormal, as the result of confinement. In shape and structure they resemble those of *saucia*, and the larvæ in the earlier stages are loopers, having the first three pairs of prolegs atrophied. They are also quite hirsute, the hairs in the first stage exceeding in length the diameter of the body, but relatively diminishing with each molt. Prof. G. H. French has given an account (Can. Ent. XIV, pp. 207–9, Nov., 1882) of the adolescent states, but as his descriptions of the larval stages are mostly colorational and omit the exceptional structural features, we append those drawn up from our own notes:

DESCRIPTIVE.

AGROTIS ANNEXA.—*Larva.*—Average length, 38^{mm}. General color dark gray, with a slightly purplish tinge on the dorsum; venter dingy white. Head same color, slightly polished, with indistinct, pale, brownish markings; the triangular frontal piece bordered each side by a dark brownish stripe, which continues in an obtuse angle on the vertex, and is crossed by some short transverse lines; a brown stripe below the eyes; quite smooth, with only a few shallow transverse wrinkles. Clypeus whitish, with six quite deep impressions; mandibles light brown at basal half, the rest black, and the edge with five teeth. Cervical shield grayish, with narrow, white median line; front margin somewhat darker; near lateral angle a paler, rather indistinct, roundish spot, which extends to the front margin in a fine line. Mediodorsal line very indistinct, and bordered each side by a dusky shade. A somewhat irregular, more or less distinct, narrow, dusky line runs from anterior margin of each joint in an oblique direction to posterior piliferous wart; subdorsal line dark gray, though not very distinct; space below subdorsal line somewhat paler than dorsum, and with indistinct, irregular, dusky marks; supra-stigmatal line whitish, bordered above by an interrupted blackish line; piliferous warts dusky, and somewhat polished; stigmata deep black. *The whole body, dorsally and ventrally, is closely covered with very minute, blackish granules, each of which bears a small, sharp point or tooth, on account of which the surface appears and feels roughened to the touch or as if covered with fine sand.*

There is considerable variation in color, the smaller specimens being generally paler, though there are also some full-grown ones of the same color; others, both small and large, are almost black. All varieties of this species may, however, be recognized by the characteristic granulations of the body. (For details see Pl. II, Fig. 1, *b*, *c*, *d*, *e*.)

Pupa.—Length, about 18^{mm}. Color reddish-brown, with a somewhat darker median line on abdomen. Head small, with the front slightly prolonged; a more or less deep impression between base of antennæ. Prothorax transversely wrinkled, the wrinkles quite coarse towards posterior margin; posterior lateral angle with a dark-brown transverse swelling, which closes the first spiracle; mesothorax almost smooth, with a short subdorsal, longitudinal impression each side; metathorax and the following three abdominal joints with quite a number of fine transverse wrinkles; abdomen with joints 4–7 anteriorly with a transverse, rounded ridge, marked with quite a number of very coarse and deep impressions, the posterior margin being very finely granulated; stigmata black; tip of last joint dark brown, ending in two stout teeth, each terminating in a very fine spine, which is curved downward; each side, just before the tip, is a small blackish tubercle, and, dorsally, a little in front of this a short spine. (See Fig. 1, *f*, *g*.)

THE SHAGREENED CUT-WORM.

(Larva of *Agrotis malefida* Guen.)

[Plate II; Fig. 3.]

This cut-worm, which has also been noticed to feed upon the cabbage-plant, appears to be confined to the Southern Atlantic States, from the District of Columbia to Alabama. Its habits are very similar to those

of *Agrotis annexa* Tr., the preceding species, in company with which, though only in small numbers, it is generally found, and from which it is not at first sight easily distinguished, having the same size, shape, general coloration, and markings. Yet a careful examination will enable its separation from *annexa* by the general surface appearing minutely shagreened and lacking the spinous elevations that cover *annexa* and cause it to feel rough when handled, while *malefida* feels smooth. It is also nocturnal in its habits and a quite general feeder, affecting, among other plants, young cotton. It also feeds freely upon clover, grass, and different weeds. It lives almost exclusively underground in a tunnel several inches in length, into which it drags the cut-off leaves and stems to devour them unmolested. It transforms about an inch below the surface, in an oval cavity, without a trace of silk. The eggs of this species are yet unknown.

DESCRIPTIVE.

AGROTIS MALEFIDA.—*Larva.*—Average length, when full grown, about 35mm. Smooth, with a greasy aspect, and, under a good lens, very finely shagreened. Color uniformly pale gray, with the venter somewhat paler. Medio-dorsal line scarcely noticeable. A more or less distinct, rather broad, dull yellowish subdorsal line, illy-defined above, but bordered below by a line which is scarcely darker than the ground color, but is itself well defined below by a faint and narrow pale line; a faint and irregular supra-stigmatal shade and a dusky stigmatal line. Stigmata large and polished, deep black. Piliferous warts normally placed, brownish, polished, each with a short, stiff, brown hair, that immediately behind the stigmata much the largest. Anal shield with the posterior edge lighter. Cervical shield more distinctly mottled with brown and with a paler median line. Second and third thoracic joints divided transversely by five narrow and quite deep wrinkles, with the transverse row of piliferous warts on the third wrinkle. Head rather small, nutant, and partly withdrawn, finely shagreened like the body, and either uniformly yellowish-brown with larger or smaller dark spots, or marked in front with the two usual brownish oblique stripes; frontal triangle concolorous; clypeus with six quite deep impressions and almost white; labrum bilobed, the lobes much rounded; antennæ, as usual, with the first joint white, the others yellow. Mandibles with five teeth, black; the basal half externally yellowish.

Pupa.—Average length, 18mm. Of normal form, yellowish-brown, polished; anal tip short, somewhat conical, and finely wrinkled, furnished with two short, stout, black thorns which at tip are slightly bent down and of a yellowish color.

THE W-MARKED CUT-WORM.

(Larva of *Agrotis clandestina* Harr.)

[Plate II; Fig. 4.]

This is a very common insect in the Northern and Western States and in Canada. It was originally described by Dr. Harris, from specimens reared in Massachusetts, and also from a specimen received from Dr. F. E. Melsheimer, of Dover, Pa. Dr. Melsheimer called the larvæ "corn cut-worms," and stated that, while their choice of food was not limited, they seemed to prefer young maize shortly after it makes its appearance above ground. They will feed, however, on all sorts of succulent vegetables; and early sown buckwheat, young pumpkin-vines, beans, and cabbages are particularly mentioned.

In our first report on the insects of Missouri we made especial mention of this species, stating that it seems to prefer to attack low bushes like currant, rather than to climb trees, indicating cabbage as especially liable to its attack, and mentioning also the fact that apple buds are occasionally eaten by this species. We also mentioned that it fed upon

a species of wild endive (probably *Cichorium sativum*), nestling under its broad leaves during the day without entering the ground, and that Mr. Glover, of the Department of Agriculture, had known it to attack wheat in Maryland.

The moths begin to appear shortly after the middle of June, and fly commonly until the end of August, or later. The larvæ hibernate in the usual manner, and transform to pupæ the latter part of May or the first of June. The eggs are yet undescribed.

The larva (Plate II, Fig. 4, *a*) and pupa were described at length in the Missouri report referred to (p. 79). The larva, when full grown, is a little over an inch in length, and is ash-gray in color, inclining to dirty yellow on the back. The distinguishing feature is a row of black velvety marks along each side of the back on all but the thoracic joints, and bearing a general resemblance, looking from anus to head, to a series of W's. The head is black, with a white line in front resembling an inverted Y.

The moth (Plate II, Fig. 4, *b*) is of a dark ash-gray color, with faintly traced wavy bands. The hind wings are dirty brownish-white, somewhat darker behind.

THE GREASY CUT-WORM.

(Larva of *Agrotis ypsilon* Rott.)

[Plate II; Fig. 2.]

We first described the larva of this insect in the *Prairie Farmer* for June 22, 1867, under the name of the "Black Cut-worm," but finding afterwards that it was quite variable in its coloration, we changed the name in our first report on the insects of Missouri (1869, p. 80) to that of the "Greasy Cut-worm." At that time the technical name *Agrotis telifera* was employed, this being the name under which the moth was first described in this country by Harris, In his Report on Insects Injurious to Vegetation, 1841, p. 323; but subsequent investigations have shown that the moth occurs also in Europe, and had been described in 1776 by Von Rottenburg, by the trivial name of *ypsilon*, and later by Hübner by the name of *suffusa*.

It is, in fact, one of the cosmopolitan insects, as widely distributed as *Heliothis armigera*—the parent of Boll-worm and Corn-worm, or as *Cynthia cardui*—the well known thistle butterfly. It is one of the commonest of our North American cut-worms, and is found from Georgia, Mississippi, and Texas, to Nova Scotia, Hudson's Bay, and Manitoba. It is found in England and all over Europe. In Asia it has been captured, in many localities in India and China. In Africa it is recorded from Egypt, South Africa, and the Cape of Good Hope. In South America specimens have been found in Venezuela, at Bahia, Brazil, and Montevideo, Uruguay. It has also been received from New Zealand, and from several localities in Australia, including Adelaide and Moreton Bay, Queensland. These localities are taken from the British Museum Catalogue. Guenée gives as the habitat of the species, all of Europe, America, and the West Indies.

The larva has a most emphatic and pernicious cutting habit. We have known it to cut off large tomato-plants that were over 6 inches in height, generally at an inch above ground. After severing one plant, the same worm would travel to other plants, and thus, in a single night, would ruin three or four. In quite hard, clayey, corn land, each

worm was found to have a smooth burrow, in which it lay hidden during the day, and to the bottom of which it could generally be traced.

Nothing seems to come amiss to its voracious appetite. It is reported as one of the species especially destructive to corn-fields and gardens. It destroys young tomato and tobacco plants, and, in confinement, feeds with equal relish on apple and grape leaves, and has been found in a garden cutting off cypress vines (*Quamoclit*). It is also one of the cotton cut-worms of the South.

No absolute proof has yet been published that it is a cabbage insect. Harris, in drawing up his description, says simply that it was one of five species of cut-worms procured in the months of June and July: "Some of them were dug up among cabbage-plants, some from potato-hills, and others from the corn-field and flower garden" (Ins. Inj. Veg., 443). We are therefore left in doubt as to whether this larva might not have been taken from the cabbage-roots. But while in Saint Louis, we received on one occasion two half-grown larva of this species from Mr. N. C. Burch, of Jefferson City, with an account of how they cut off his cabbage plants below and above the ground (May 3, 1869), and in May, 1870, we found the partly grown larvæ cutting off young cabbages about one-half inch above the ground.

There is with this species either a dual method of hibernation or else it is double-brooded. Lists of local fauna show that the moth has been captured abundantly in Massachusetts in April, and again in August, September, and October. In Canada it is found from June to October, and a perfectly fresh specimen has been taken as late as October 1. In Missouri, on several occasions between 1868 and 1876, we took full-grown larvæ about May 1, but in no instance did they transform to moths before July, and in one case the transformation was delayed until late in August, whether abnormally or not, we cannot say. Farther south the pupa has been several times plowed up during the winter months and mistaken for the pupa of the cotton-worm. December 3, 1878, one was found at Virginia Point, Tex., which gave forth the moth on the 6th. April 22 a number of the pupæ were sent to us which had been plowed up in a cotton-field at Americus, Ga.; the moths issued before the close of the month. The evidence would seem to show either that there is great irregularity in the time of development and mode of hibernation, or that there are two broods in the Northern States, and no more in Illinois and Missouri.

We have already given (First Missouri Report, p. 80) descriptions of the larva, pupa, and adult, which it will be unnecessary to repeat here. The larva (Plate I, Fig. 2, *a*, *b*), is about an inch and a half long, of a dull lead-brown color, with five longitudinal indistinct lighter stripes. The underside of the body is dim greenish-yellow. The moth (Plate II, Fig. 2, *c*) has dark-brown front wings, with a bluish tinge on the fore border, and with a dark brown lance-shaped mark running from the posterior portion of a kidney-shaped spot in the middle of the wing. The hind wings are pearly white and semi-transparent.

The eggs, which have not before been described, are laid in small batches, and often in two or three layers, covered sparsely with long scales from the abdomen of the female moth. They are pale fulvous in color and nearly spherical in shape, the base being somewhat flattened. The polar ribs are not very distinct, and the crown is small. These eggs we have found laid on peach and sycamore leaves upon which the larvæ do not feed. The larva in the first stage is, also, a semi-looper, the front prolegs being atrophied. The species is parasitized by Tachinidæ, which we have often bred from it.

THE SPECKLED CUT-WORM.

(Larva of *Mamestra subjuncta* G. & R.)

[Plate II; Fig. 5.]

This cut-worm was also one of the species described and figured by us in the first report on the insects of Missouri for 1868. We found it on two occasions hiding under cabbage-plants in a truck garden in Saint Louis, and in confinement it feeds ravenously on cabbage-leaves, so that it may safely be put down as a cabbage insect.

The species has been found in Missouri, Wisconsin, Canada, and Massachusetts, and probably occupies all the intermediate ground, if it does not extend beyond these limits.

So far as is known there is but one annual generation, and the moths fly in Massachusetts in June and July, in Canada in July and August. A favorite hiding place for the worms in the spring is under bits of manure in clover-fields. This cut-worm is parasitized by the ichneumonid *Paniscus geminatus* of Say, a large species which deposits a single egg on each worm. The tough, black, silvery cocoon of the parasite is spun within the pupa of the cut-worm and completely fills the cavity.

Full descriptions of the different stages will be found in the report just referred to. The larva (Figs. *a*, *b*, *c*) is at once distinguished by several characteristics, but more especially by being speckled as with pepper and salt, when viewed with a pocket lens, the ground color being flesh-gray, with a tinge of rust color in the middle of each joint. Before changing to chrysalis it acquires a uniform, pale, dirty yellow color with the markings almost obliterated. It bears an interrupted dorsal and subdorsal white line, these lines being quite distinct on the posterior half, and indistinct on the anterior half, of each joint; and a stigmatal line on each side, somewhat lighter than the rest of the body.

The moth (Plate II, Fig. 5, *d*) expands 38^{mm}. The front wings are blackish-brown above, shaded with flesh-color, and are characterized by the ordinary spots being very large, flesh-colored, and distinctly limited. The hind wings are smoky-blackish, paler toward the base, and marked obscurely, if at all. The eggs of this species, which have not hitherto been known, are laid (as we have ascertained in confinement) in the fall in batches of from fifty to sixty, and generally in two layers. In shape they closely resemble those of *saucia*, which we figure, and in color they are at first of a pale bluish-green, becoming reddish-brown before hatching. The young larvæ are, also, semi-loopers, the first and second pairs of prolegs being atrophied.

THE GLASSY CUT-WORM.

(Larva of *Hadena devastatrix*, Brace.)

[Plate III; Figs. 3, 4.]

We have already referred to the five species of cut-worm moths bred by Dr. Harris from a miscellaneous lot of worms, and described without reference to their distinctive larvæ. He states that he was assured by one of his friends that his fifth species was the moth of "the Cabbage Cut-worm." Dr. Harris identified this moth with the *Phalaena Noctua devastator*, described by Mr. John P. Brace in Silliman's Journal, Vol. 1

(1818), p. 154, and placed it in the genus Agrotis. The original description was drawn up by Mr. Brace from moths bred from pupæ found in a cabbage-field, and there remains but little doubt that it is a true cabbage insect.

The larva of this species was unknown until 1869, when we published a full description of it (*loc. cit.*, p. 83). The larva from which this description was taken was found May 1 under a wild endive, the leaves of which it had evidently been eating. It was about half grown. In the breeding-jar to which it was transferred, it burrowed immediately under ground and fed until the time of its transformation entirely on grass-roots, although other food was plentiful. On June 19 it changed to a pupa, and came forth as a moth July 7.

Mr. Brace's account of its life-history was to a certain extent erroneous. He stated that the moth lays its eggs in the autumn, near the ground and at the roots of trees; that the eggs hatch the following May and the worms attain their growth in four weeks, remain in the pupa state four weeks longer, and come forth as moths about the middle of July. Dr. Harris, however, justly criticises this statement in the following words: "From what is known respecting the history of the other kinds of Agrotis and from the size that the Cabbage Cut-worms are found to have attained in May, I am led to infer that they must generally be hatched in the previous autumn, and that, after feeding awhile on such food as they can find immediately under the surface of the soil, they descend deeper into the ground and remain curled up in little cavities which each one makes for itself in the earth till the following spring."

The Glassy Cut-worm (Plate III, Fig. 3) may at once be distinguished from the other cut-worms which we have described by its translucent, glassy-green body, in contrast with the very distinct, hard, polished, dark-brown cervical shield, and a bright venetian-red head.

The moth (Plate III, Fig. 4) resembles in general appearance *Agrotis messoria*, previously described, the ground-color being the same. It is larger in size, the wavy, transverse lines are more nearly equidistant, the arrow-shaped spots which emanate from the outer line are darker and more distinct, and the outer edge of the large kidney-shaped spot is almost always quite white. These are the superficial characters by which they may be distinguished, as by their structural characters they are placed in different genera. No description of the eggs has been published.

THE VARIEGATED CUT-WORM.

(Larva of *Agrotis saucia* Treitschke.)

[Plate III; Figs. 1, 2.]

This cut-worm was treated of in our First Missouri Entomological Report (pp. 72-74) under the name of *Agrotis inermis* Harris. It is a common species throughout North America and Europe, and has been found in the islands of Madeira and Teneriffe. It is a very general feeder. Kaltenbach mentions it as feeding upon *Stellaria*, *Litorella*, *Plantago*, and *Rumex* in Europe. In this country we have found these larvæ abundantly in cabbage-patches, and have fed them in confinement upon cabbage, grape leaves, strawberry leaves, and the leaves of Eupatorium, and also of White mulberry. We also, upon one occasion, found a single larva climbing in a willow tree in the day-time, and this specimen

was fed upon willow leaves. We have known it to do considerable damage to young grape-vines in cold frames, as well as to young lettuce plants, and one of our correspondents accidentally raised a number of larvæ from the egg to half growth which had fed exclusively on apples, form want of other food.

The eggs of this species (Plate III, Fig. 2) are quite small, of a pink color, with ribs radiating from the summit, and are deposited in small batches. From the evidence which we have collected it seems to be the universal habit of this species to lay its eggs upon the leaves of various trees. We have found them upon the leaves of Cherry, Apple, Mulberry, and Peach, and have never found them in other situations.

The newly-hatched larva is dirty yellow in color, covered with dark conspicuous spots; it feeds openly and loops somewhat in its walk. After the first molt the dark spots become almost obliterated, and it takes on the appearance of the full-grown worm, assuming at the same time the normal cut-worm habit. The full-grown larva (Plate III, Fig. 1, *a*, *b*, *c*) is about 2 inches long, is finely mottled with dull flesh-brown and black, and has dark velvety, longitudinal marks along the sides of the back. It is lighter on the sides than on the back, and has a flesh-colored stripe below the stigmata. The pupa is of normal form, deep mahogany-brown in color, and has a single point at its extremity.

The general color of the moth (Plate III, Fig. 1, *d*) is dark brownish-gray, some specimens being almost black along the front edge of the upper wings, while others have this edge of a dull golden-buff color.

The development of the species is quite rapid, as will be seen by the following extracts from our notes:

Eggs found on apple hatched April 17; larvæ entered the ground May 15 to 22; moths issued June 3 to 8.

Eggs found on leaf of mulberry hatched May 24; larvæ entered the ground June 15; moths issued June 28 to July 5.

Eggs found on peach twig hatched April 9. Another batch hatched April 25; moths from the latter batch issued June 26.

Batch of eggs found April 29 hatch May 2; larvæ entered ground May 31; moths issued June 17.

These notes were all made at Saint Louis, and indicate at least two annual generations, with a possibility of three.

For detailed descriptions of the different stages we refer the reader to the report cited in the opening sentence.

REMEDIES FOR CABBAGE CUT-WORMS.

Up to quite recent times no good remedy for cut-worms had been proposed which did not involve much time and labor in the carrying out. The use of dressings for the soil was found unsatisfactory; fall plowing accomplished the end incompletely; applications to the plants were not lasting in their effects; and the best writers, including Curtis, Harris, and Fitch, have concluded that digging the worms out of their burrows by hand and destroying them is the only complete and satisfactory thing to do.

A preventive urged by one of Harris's correspondents was, to wrap the stem of the young plant, on setting it out, in a walnut leaf, through which the worms will not penetrate to reach the stem, and the same idea has since been used with good effect in small gardens, with the substitution of heavy brown paper for the walnut leaf. A good deal of time and care is necessary to make a perfect wrapping of the stem, and

this constitutes, so far as we are aware, the only objection to the use of this preventive.

One of the very oldest of the cut-worm remedies consists in trapping the worms in deep holes near the base of the plants. For this purpose a long, smooth, sharpened stake, an inch or two in diameter, is used, and almost as fast as a person can walk through the field it can be thrust once or twice deep into the ground near each plant, leaving a smooth, round hole out of which the cut-worms, having once fallen in, cannot crawl, and the chances are that in their nocturnal prowlings they are pretty sure to drop into these wells. In connection with this remedy it has always been advised to go through the field in the morning and crush the worms by again thrusting the stake into each hole; but where the soil is a stiff clay this is unnecessary labor, as, if the hole left by the dibble be smooth and firm, the worms do no further harm, as they cannot escape and will in the majority of cases perish without transforming. This remedy was advocated in the newspapers as long ago as 1817, and we have frequently employed it to advantage.

Dr. Fitch was of the opinion that vegetable gardens and corn-fields were in a measure, if not chiefly, supplied with the worms from neighboring pastures and grass lots. He, therefore, advised the plowing of a single deep furrow around the field to be protected, experiments having shown him the extreme difficulty with which the worms climb a nearly perpendicular bank of earth. Fall plowing has also been recommended, but is chiefly useful in clearing the ground of weeds upon which the young worms are nourished, and the more thoroughly a piece of land intended for cabbage is kept clean, from September till planting time the ensuing spring, the more free it will be from cut-worms.

We have now to record what we have proved by experience to be a more effectual method of ridding land of cut-worms than any of those hitherto proposed. It is, in brief, the use of poisoned balls of any succulent plant, a method which we successfully used in Missouri in 1875. One of our most valued correspondents, Dr. A. Oemler, of Wilmington Island, near Savannah, Ga., has long fought cut-worms by trapping them under leaves and grass. To make use of his own words:

"My method of dealing with cut-worms of late years has been to remove them from the field before the crop to be jeopardized is up or the plants are put out. By placing cabbage leaves and bundles of grass along the rows of watermelon-hills four years ago, I caught, by hunting them daily, 1,538 worms on about one-fourth of an acre, before the seed came up, and lost but a single melon plant. On one occasion I captured, one morning, fifty-eight of all sizes under a single turnip leaf, and my son found fifteen at the root of a single small cabbage plant."

A year or so ago we wrote Dr. Oemler that his remedy would be much improved in point of economy of labor, if he poisoned his traps before setting them, or, in other words, if he sprinkled his cabbage leaves or grass, or other forage used for this purpose, with a solution of Paris green or London purple, in order to save himself the trouble of hunting for the worms in the morning.

We again quote from Dr. Oemler concerning the practical working of this plan:

"After the land is prepared for cabbages or any other crop needing protection, I place cabbage or turnip leaves in rows 15 or 20 feet apart all over the field, and about the same distance apart in the rows. The leaves are first dipped in a well-stirred mixture of a tablespoonful of Paris green to the bucket of water; or they may be first

moistened, then dusted with a mixture of one part of Paris green to twenty of flour, and placed carefully with the dusted surface next to the ground. Two such applications, particularly in cloudy weather, at intervals of three or four days, will suffice to allow the cut-worms to make away with themselves, which they generally do with perfect success. This plan, first recommended by Professor Riley, is the best I have found. Whoever adopts it will rid himself of the pest at least cost and trouble, and will not be compelled to replant constantly or to sow his seed thickly."*

In our own experience we used chiefly clover sprinkled with Paris-green water and laid at intervals between the rows, in loosely-tied masses or balls, which served the double purpose of prolonging the freshness of the bait and of affording a lure for shelter.

OTHER CABBAGE INSECTS.

THE IMBRICATED SNOUT-BEETLE.

(*Epicærus imbricatus* Say.)

Order COLEOPTERA; family OTIORHYNCHIDÆ.

[Plate III; Fig. 5.]

This widely-distributed beetle, found in every portion of our territory east of the Rocky Mountains and south and west of Pennsylvania, was first figured by us in the *Prairie Farmer* for July 18, 1863, for an article by Mr. Walsh, and subsequently treated as an injurious species in our Third Missouri Entomological Report. We there stated that it frequently damaged apple and cherry trees and gooseberry bushes by gnawing the trees and fruit, and that it was a native of the more Western States, occurring much more commonly west than east of the Mississippi.

In 1873 we received it from Iowa as doing some damage to corn, and it is often quite abundant in corn-fields in Western States. In 1879 this weevil made its appearance in great numbers in Monroe County, East Tennessee. Upon the truck farm of Mr. Thomas G. Boyd, of Sweetwater, it was especially numerous, destroying not only cabbages, but radishes, beans, watermelons, muskmelons, cucumbers, corn, and beets. Peas, parsnips, carrots, and tomatoes were not touched. Onions suffered particularly, and stalks were sent to the Department filled with holes gnawed by the weevil. In treating of this occurrence, Professor Comstock (Annual Report Department of Agriculture, 1879, p. 249, issued October, 1880), said:

"From this remarkable occurrence on so many new food-plants and so far east, this insect becomes of the first importance, and the Eastern market gardeners may ere long have a new foe to contend with."

Curiously enough, before this report was out of press we received specimens of the same insect from Prof. George Thurber, of New York City, with the statement that they had been received from Felton, Del., where they were "destroying the early cabbage, eating the leaves, and sucking the juice from the stem." This statement we published in the *American Entomologist* for August, 1880 (Vol. III; new series, Vol. I, p. 200). The beetle had not been noticed in that locality before as a

* Truck-farming at the South. A guide to the raising of vegetables for the northern markets, by Dr. A. Oemler. Orange Judd Company, 1883.

pest, and, contrary to our expectations, it seems not to have done much damage since.

This beetle has the habit of "playing possum," a habit which is common to many of the snout-beetles.

The early stages of the species have not yet been observed, but the larvæ will, without much doubt, be found feeding upon the roots (externally) of one or more of the food-plants of the adult beetle, just as do the larvæ of Fuller's Rose-Beetle (*Aomopactes fulleri*), described in our annual report to this Department for 1878.

From its habits it will be found difficult to contend with this insect when it occurs unexpectedly and in large numbers. In small gardens the vegetables can be saved by hand-picking the beetles, and in cases where it occurs on large truck farms we should advise the use of the pyrethrum infusion. We know this to be effectual with the rose-beetle above mentioned.

A beetle, belonging to the same family as the preceding, is reported by Dr. Packard (Second Ann. Rep. as Entomologist of Massachusetts, 1872, pp. 14, 15; repeated in Hayden's 9th U. S. Geol. Surv., 1875, p. 575) as being not uncommon in Essex County, Massachusetts. It is the *Otiorhynchus picipes*, Fabr., and is believed to be an importation from England, where it does much damage, according to Curtis, to Cabbage and other cruciferæ. It is very doubtful, however, whether Packard has correctly determined the species, as coleopterists do not recognize it as occurring in America. It is probable that one of the other two species of the genus that are known to occur in Massachusetts, viz, *sulcatus* and *ligneus*, have been confounded with it.

THE WAVY-STRIPED FLEA-BEETLE.

(*Phyllotreta vittata*, Fabricius.)

Order COLEOPTERA; family CHRYSOMELIDÆ.

[Plate III; Fig. 6.]

HABITS AND NATURAL HISTORY.

This little insect is one of our most familiar garden pests. It abounds throughout the summer on all our cruciferous vegetables, as cabbage, turnip, radish, mustard; upon charlock (*Sinapis*), shepherd's purse, (*Capsella*), stock (*Matthiola*) rocket (*Hesperis*), and many other plants of the same family, occasionally going without its limits and feeding upon other convenient plants, such as the common garden pea. It often occurs in great numbers, and injures the cabbage crop severely. Its general appearance is well known to all gardeners. It is oval in shape, one-tenth of an inch long, shining black in color, except that the wing-covers have each a broad, wavy, longitudinal band of a pale yellow color. Its hind thighs are greatly enlarged, and it is a great jumper, as the popular name would indicate. The work of the beetle itself upon cabbage consists in eating innumerable small pits into the surface of the leaf, never, except upon the tenderest and thinnest extremities, eating through the leaf-substance. With the thin-leaved mustard, however, the case is different, and the foliage becomes riddled with holes.

The habits of this flea-beetle have been written upon by Harris, Fitch, Shimer, and others. Harris had no knowledge of the immature forms (Ins. Inj. to Veg., p. 129). Fitch (Eleventh Report, Ins. N. Y., p. 45)

described at length the observations of Mr. H. Le Keux (Trans. Ent. Soc. Lond. II., 24) upon the closely allied European *Haltica nemorum*, showing that the larvæ ruined the leaves of turnips and allied plants, and pupated under ground. Then, having remarked upon the similarity in appearance between the two species, he goes on to say: "This account will consequently apply to our insect in every respect, it is probable, as exactly as though it was the insect upon which the observations were made."

The fallacy of this belief was shown by Dr. Shimer (*American Naturalist*, II, 1869, p. 514, and *American Entomologist*, I, p. 158), who has recorded numerous observations proving that the larvæ live underground, feeding upon the roots of cruciferous plants. Concerning the damage done by the larvæ, he says:

"Every year the young cabbage plants and turnips in this region (Mount Carroll, Carroll County, Illinois) receive great damage from these larvæ, and often when we have dry weather, in the latter part of May and early in June, the cabbage plants are ruined. A large proportion of the plants are killed outright in June, and the balance rendered scarcely fit for planting, but when the ground is wet to the surface all the time, by frequent rains, the young plant is able to defend itself much more effectually by throwing out roots at the surface of the ground when the main or center root is devoured by the larva; but in dry weather these surface roots find no nourishment, and the plant must perish."

These observations have been confirmed by our own and by those of several of our correspondents, among them Dr. A. W. Hoffmeister, of Fort Madison, Iowa. The case, however, is complicated from the fact that a very closely-allied species (*Phyllotreta zimmermanni*), which we shall treat of next, is a leaf-miner in the larva state.

The eggs of the Wavy-striped Flea-beetle, as found upon radishes by Miss Murtfeldt, are deposited two or three together upon the root near the crown, in an irregular excavation gnawed by the perfect beetle. They are very minute and fragile, of an oval form and a translucent white color. The larva (Plate III, Fig. 6, *a*) is slender, subcylindrical, and tapers at each end. The color is pale yellowish-white, with brown head and anal plate, and with thoracic marks and transverse rows of minute hair-bearing warts, as in the figure.

REMEDIES.

The question of remedies is one which has not been very satisfactorily solved, though with care and watchfulness it is possible to keep vegetables almost entirely free from this flea-beetle. Dr. Fitch details experiments with many of the substances recommended, and his conclusions, from his own experiments and those of Le Keux and others, are about as follows:

The beetles pretty generally forsake the plants which have been dusted with lime, plaster, ashes, soot, Scotch snuff, sulphur, or with two or three of these substances mixed. Dry unleached ashes seem to produce the most marked effect in driving away the beetles. "But," Dr. Fitch goes on to say, "although these substances, ashes especially, usually suffice for driving these flea-beetles from the plants, my observations assure me of the fact that a season occasionally arrives when they fail of having any perceptible effect. The insects at times become more bold and fearless than is their common habit. Numbers of them will cling to the leaf, regardless of the dust falling upon them, and

some individuals being stationed in the little pits which they have eaten in the thick texture of the leaves, and others down in the axils at the base of the leaf-stalks, pertinaciously remain, regardless of any jarring or shaking of the plants, and are only dislodged by crowding them out from their lairs with the point of a knife or other implement. And though the plants be kept well dusted over with ashes, and the beetles repeatedly driven off from them, they immediately return to them again."

It is the occasional occurrence of a season like this which is the cause of so many contradictory opinions upon the efficacy of this or that particular remedy. But these remedies which have been mentioned have no effect in actually lessening the numbers of the beetles—they simply drive these from one patch to another. Dr. Fitch heartily recommended the keeping of broods of young chickens in the kitchen garden, and described the activity with which these fowls search for the flea-beetles and the avidity with which they devour them. He also advised the domestication of toads in the garden on the testimony of a speaker at the American Institute Farmers' Club, in 1864, who had cut open a toad which he feared was feeding on his bees, and examined its stomach, in which he found "two long, hairy caterpillars, and numerous heads and parts of beetles; but the bulk was made up of a sort of cabbage beetle or flea, jet black, of small size, with a hard shell, which I had noticed very abundant on my cabbages and turnips."

These remedies may of course answer in small gardens, where but a few heads are grown, and will also considerably reduce the damage in larger fields; but large truck farmers need something better, and we have little doubt but that the Pyrethrum mixture or the infusion will meet the wants of the case. No conclusive experiments have as yet been tried. Miss Murtfeldt, whom we charged to make particular observations and experiments on this insect, has reported as follows as to Pyrethrum: "Its effect on the Striped Flea-beetle which riddles the young leaves of cabbage, cresses, and other cruciferous plants is rather to drive the beetles off than to kill them. It seldom absolutely kills them, but if thickly applied it produces temporary stupefaction. There are at least two successive broods of this beetle, appearing in greatest numbers during the latter part of May and of July; and if the powder be applied occasionally to plants liable to attack at these seasons, a great deal of injury may be averted." In another place she gives an entry from her diary, as follows: "July 7. Used the powder freely on some plants of sweet alyssum that were being ruined by the Striped Flea-beetle. It did not produce any immediate paralyzing effect, but evidently caused the beetles to 'vacate,' as none of the latter were to be found on or about the plants on the succeeding day."

The remedy employed by Mr. P. T. Quinn, the well-known fruit and vegetable grower, for both this and the Striped Cucumber-beetle is well worthy of mention here. He sprinkles his vines with a liquid made chiefly of soaked tobacco stems and soft soap, and then powders them with lime.

The following experience of Mr. J. M. Nicholson, of Godkinville, N. C., which we published in the *Rural New Yorker* for November 3, 1883, is, however, well worthy of being put on record as a most ingenious way of perpetuating the effect of the solution. Mr. Nicholson writes in a recent letter as follows: "I would mention a simple contrivance which I have made and used with perfect success in exterminating bugs on melon and cucumber vines. I took old oyster and fruit cans (tin) and filled them with a strong decoction of tobacco-stems and water. I poured it on the

stems hot and allowed it to cool. I set one can on each hill and placed therein a woolen string (in thickness about the size of a wheat straw), thoroughly wet it, and allowed it to hang to the plants. The string acts as a siphon, and draws the liquid out drop by drop, and keeps the plant continually moistened with the offensive liquid, thus driving all insects away. It further assists in the growth of the plants by keeping the roots moist, yet so continual and gradual is the application that the sun neither scalds nor bakes the earth. I merely mention this, as it may be something new, and I assure you it is worthy of a trial, as it proved entirely satisfactory to me this season.

DESCRIPTIVE.

PHYLLOTRETA VITTATA.—*Larva.*—Length, 5^{mm}; width, 0.7^{mm}. A long, slender, subcylindrical larva, tapering but slightly at either end. The general color is yellowish-white; head dark brown, mandibles still darker, and labrum light brown. The dorsum of every abdominal joint, except the last, is marked with two nearly transverse rows of about ten very small, dark, piliferous warts, the rows separating near the dorsal line and approximating laterally. The legs are well developed, and the coxa of each has an irregular dark-brown, chitinous ring, which sends a short prolongation down the anterior portion of each femur. The tarsi each support an obconical pulvillus, but no claws. The base of this pulvillus presents the appearance of a sucking disk.

The general surface of the body is microscopically granulate. The prothoracic plate is not well marked, and is of a broad, irregular, hexagonal shape. The anal plate is heavy, brown in color, and occupies the whole of the dorsum of the anal joint. Its lateral edges bear eight stout hairs, and upon its dorsal surface are eight more, one transverse row of four near the middle of the joint, a transverse row of two immediately behind this, and one near each anterior corner. The antennæ are very short and stout, and 2-jointed. The maxillary palpi are large, conical, and apparently 3-jointed, differing from those of the European *nemorum* in that the first joint is long and stout, while the second joint is insignificant; in *nemorum* the second is very prominent. Labial palpi very short, 2-jointed. The mandibles are stout and 4-dentate; the first two teeth are large and sharp, the third smaller, and the fourth small and rounded. The maxillæ are conical, and each bears a tuft of stout bristles. The labrum is prominent, and its front border forms at tip approximately an arc of a circle; it is rugose at its anterior border, but not subdentate, as with *nemorum*. The chitinous patches, so strong over the integument of *zimmermanni*, are but faintly indicated here.

ZIMMERMANN'S FLEA-BEETLE.

(*Phyllotreta zimmermanni*, Crotch.)

Order COLEOPTERA; Family CHRYSOMELIDÆ.

[Plate IV; Fig. 1.]

This little beetle (Plate IV, Fig. 1, *d*) much resembles the preceding species (*Ph. vittata*), and as it is also found upon cabbage and other cruciferous plants, although seldom if ever in such numbers as the other, the two species are without doubt often confounded. The larvæ, too, are quite similar, but differ widely in habit. Instead of feeding upon the roots, that of *zimmermanni* mines the leaves of certain cruciferous plants, and notably the wild Pepper-grass (*Lepidium virginicum*). While the habits of the former have been long since known, those of the latter have not hitherto been published. We first bred it from *Lepidium* in 1872 at Saint Louis, and the following account is taken from our notes of that time, and from more recent observations made at our request by Miss M. E. Murtfeldt, at Kirkwood, Mo.

The wild Pepper-grass upon which the insect is found is one of the most common and abundant weeds in that locality, and, during the

months of May and June, it is difficult to find a plant that is not blotched and discolored by the larvæ of this flea-beetle, many plants being entirely killed thereby. The larva is not confined to a single mine or even to a single leaf, but will leave one mine and form another in some cases where there is no evident reason for so doing. When full-grown (Plate IV, Fig. 1, *a*) it crawls or drops to the ground and pupates in an oval cell just beneath the surface (Plate IV, Fig. 1, *c*, pupa). The eggs are deposited upon the upper surface of the leaf along the mid-vein, and are each about 0.02^{mm} long, or just large enough to be perceptible to the unaided eye. They are of a depressed, oblong shape, glued singly and flatly to the leaf. The color is dull white, with a tinge of green, and the surface under the lens appears fretted or shagreened.

The young larvæ work their way from the under side through the cuticle of the leaf. In May and June the entire cycle of development from egg to perfect insect occupies only from twenty to twenty-two or twenty-three days. The only other plant except the Lepidium which the larvæ have been found to mine is the delicate and pungent *Arabis ludoviciana*, which is sparingly attacked.

The male of this species is readily distinguished from *vittata* by the dilated fifth joint of the antennæ (Plate IV, Fig. 1, *e*), but the females are less easily separated, and in order to bring out more strikingly the differences which invariably distinguish these two beetles, which in general appearance are so easily confounded, we have drawn up, from abundant material of both species, the following comparative table:

Zimmermanni.	*Vittata.*
FORM.	
Ovate, convex.	Oval, more convex.
HEAD.	
Strongly carinate anteriorly, front smooth, shining with fine median sulcus; vertex finely and transversely aciculate and sparsely and finely punctulate.	Strongly carinate anteriorly, front smooth, shining, with distinct median sulcus; vertex not aciculate, sparsely, but more clearly punctulate.
ANTENNÆ.	
Differing considerably in length and structure according to the sexes. Joints 2, 3, 4 reddish; joint 1 blackish above and reddish beneath.	Not differing much in length and structure according to the sexes. Joints 1, 2, 3 clear reddish yellow.
THORAX.	
Usually finely and transversely aciculate, moderately and sparsely punctulate, punctations larger at base and sides than in front.	Aciculation usually not obvious, punctation variable but usually denser.
ELYTRA.	
Almost parallel at the sides. Sculpture variable in strength, punctations arranged in rows on the disk. Yellow vitta not much subject to variation, hardly ever interrupted at middle, usually pale and *narrow, incurved only at apex;* deeply and widely emarginate at outer side, inner side almost straight.	*Rounded at the sides.* Sculpture variable, but usually finer and less distinctly seriate. Yellow vitta considerably subject to variation, frequently interrupted at middle, usually bright yellow and *wider; incurved at base and apex;* very deeply emarginate at outer side, inner side sinuate.

KNEES, TIBIÆ, AND TARSI.

Either partly or wholly piceous-red.	Piceo-testaceous, often clear yellow.

♂

Antennæ stout, joint 4 subquadrate and wider than joint 3; joint 5 as long as the two preceding joints, and more than twice as wide as the following joints, elongate-quadrate, flattened; joint 6 very small, only one-half as long as joint 7.	Antennæ more slender; joint 4 not wider and hardly shorter than joint 3; joint 5 normally not wider, but one-third longer than joint 4, not flattened; joint 6 one-half shorter than joint 7.
Last ventral segment with smooth impressed median line, apical impression moderately deep and traversed by the median line.	Last ventral segment without median line; apical impression shallow and ill-defined.

♀

Antennæ more slender than in ♂, joint 4 not wider than the rest, and as long as joint 3; joint 5 a little longer than joint 4, not dilated; joint 6 about one-third shorter than joint 7.	Antennæ hardly more slender than in ♂; joint 5 very little longer and never wider than joint 4; joint 6 as in the ♂.
Last ventral segment simple.	Last ventral segment simple.

DESCRIPTIVE OF ADOLESCENT STATES.

PHYLLOTRETA ZIMMERMANNI.—*Larva*.—(Plate IV, Fig. 1, *a*, *b*).—In length, size, and shape very similar to *P. vittata*. Color dark orange, ornamented with dark brown or black; head dark brown, nearly black; prothoracic shield prominent and nearly black; the other thoracic joints bear each side of dorsal line two subtriangular brown chitinous patches, and sublaterally a triangular brown spot. Each abdominal joint bears dorsally three rows of small but very distinct chitinous patches, the middle one of the posterior row largest. The ventral surface of each abdominal joint is marked with four similar chitinous patches. The whole surface of the integument, excepting, of course, the chitinous portions, is seen with a low power to be covered with regular, brownish granulations. The anal plate bears the same number of hairs in nearly the same relative position as in *vittata*. The mouth parts (Plate IV, Fig. 1, *b*) differ in the mandibles bearing a rudimentary fifth tooth, and in the relative proportion of the joints of the maxillary palpi, in which characters it comes nearer to *nemorum* than to *vittata*. In other respects the resemblance to *vittata* is marked.

The larva of *nemorum* seems to be intermediate between those of *vittata* and *zimmermanni*, bearing the chitinous spots, but not so markedly as in *zimmermanni*.

Pupa (Pl. IV, Fig. 1, *c*).—White, stout, of the same size and shape as the adult beetle. The wings sheaths, when naturally folded, extend to the tip of the abdomen. The antennæ are bent around ventrally so as to reach near the hind coxæ. The whole surface of the body is furnished with many stout bristles, and the anal segment ends in two short, incurved, calliper-like setæ.

While there is no difficulty in distinguishing the two species under consideration by the characters given above, upon examination of a large number of specimens most of the distinguishing characters are found to be subject to variation. Even the secondary sexual characters in the antennæ are not constant; in *zimmermanni* the dilatation of the fifth joint varies in extent, while in *vittata* the fifth joint not unfrequently is wider than the other joints, thus showing a tendency to become enlarged, as in the former species. Still, in *vittata* the dilatation of the fifth joint is never so marked as in *zimmermanni*, and males of the two species can always safely be distinguished by this character. The form of the body is another character which is very constant, though very large specimens of *vittata* approach the more ovate form seen in *zimmermanni*. The most constant character, however, is the form of the yellow elytral vitta, which is straight at base in *zimmermanni*, and always incurved in *vittata*. Specimens of the latter species, in which the vitta

is interrupted in the middle, very closely approach *bipustulata* Fabr. This species, in company with the two species we have considered, occurs sometimes on the same plants. It is of the same size as large specimens of *vittata*, from which it may be distinguished as follows: The antennæ have the five or six basal joints bright orange yellow, the two elytral spots are bright yellow, the subhumeral spot almost reaching the side margin, and being rounded behind (not sinuate or indented, as in *vittata*, with interrupted vitta). The knees, tibiæ, and tarsi are also bright yellow. The only structural differences are, however, the secondary sexual characters, viz., the ♂ has the antennæ simple and the apical impression of the last ventral joint is large, very deep, and well defined.

Among the numerous species of jumping leaf-beetles (*Halticinæ*) the yellow-striped species of Phyllotreta may at once be distinguished by their small size, the markings on the elytra, and by their remarkable jumping power, in which they far surpass the more clumsy cucumber and grape-vine Flea-beetles, and in which they are only equaled by the species of Longitarsus.

But the species of this group are difficult to distinguish. There are seven species described from North America, of which three seem to be peculiar to the western portion of the continent, and have not been reported as injurious to agriculture. Of the four eastern species, *Ph. robusta* seems to be rare, and occurs in Michigan; *bipustulata* is not common, and occurs in the more Southern States; *zimmermanni* in the Middle and Southern States; *vittata* in the Northern, Middle, and Southern States. There can be but little question that the geographical limits of the most common species have been and are still being enlarged by the cultivation of cabbage and allied plants.

A large number of species of this genus have been described from Europe, mostly occurring on cruciferous plants, and several reported as injurious to cultivated Cruciferæ; but it appears that the natural history of but one species (*Ph. nemorum*) has been studied, and it has habits similar to those of *zimmermanni*. Several of these species are among the most common species of the European Coleopterous fauna, and it is a wonder that none of them have, so far, been introduced into this country.

The food-plants of the genus in Europe are chiefly Cruciferæ. Besides the cultivated species, the following genera may be added: Sisymbrium, Capsella, Sinapis, Nasturtium; while, of other families, Reseda, Plantago, and Quercus are also reported to be food-plants of the genus.

NATURAL ENEMIES.

From the leaf mines on Lepidium we have bred the following parasite on *Phyllotreta zimmermanni*. It is a Chalcid, and belongs to the Entedonid genus *Pleurotropis* of Foerster:

PLEUROTROPIS PHYLLOTRETÆ n. sp.—*Female*.—Length of body, 1.67^{mm}; expanse of wings, 3.26^{mm}; greatest width of front wing, 0.58^{mm}. Antennal scape slender, inserted below the middle of the face, and reaching nearly to ocelli; funicle 3-jointed, joints somewhat hairy; one ring joint; club 2-jointed. Facial depression definitely marked, sending off a ramus towards the eye; cheeks rather prominent, slightly punctate; vertex broad, smooth, slightly punctate near eyes; occiput delicately but densely punctate. Pronotum with a strongly marked anterior border; mesoscutum densely punctate; parapsides of mesoscutum indicated by depressions anteriorly and posteriorly; metanotum with a well-marked median carina, nearly smooth on the sides. Petiole short, transverse, punctate. Abdomen broadly ovoid, smooth, first segment very large, and the others may be almost entirely drawn within it. Submarginal

vein of front wing close to costa, and furnished with two or three bristles; marginal vein longer and stouter than submarginal; stigmal short and oval; post-marginal plainly present, but shorter even than the stigmal. Color, dark metallic green; wing veins brown; all legs concolorous with body, tarsi brown, and each tarsal joint with a central metallic tinge.

The *male* differs in its longer abdominal petiole, and in a more marked division of the club into two joints.

Described from 5 ♀ and 3 ♂ specimens, bred from larvæ of *Phyllotreta zimmermanni* mining leaves of Lepidium, in Missouri.

THE COLORADO CABBAGE FLEA-BEETLE.

(*Phyllotreta albionica*, Le Conte.)

Order COLEOPTERA; Family CHRYSOMELIDÆ.

[Plate IX; Fig. 7.]

Another flea-beetle injurious to Cabbage and other Cruciferous plants, is common in June and July throughout the Rocky Mountain region of Colorado, having been found in great numbers at the very highest elevations. It is somewhat smaller than the preceding species, and of a uniform, deep, polished, olive-green color, and irregularly punctate. The antennæ are dark and pubescent, with joints 3, 4, and 5 reddish-brown. Its larval history has not been recorded, but will probably resemble that of *vittata*.

There is another species (*P. oregonensis*, Crotch) which occurs on the Pacific coast, and which very closely resembles *vittata*. We have received it from Mrs. A. E. Bush, of San José, Cal., and it doubtless affects Cabbage there.

THE COLORADO POTATO-BEETLE.

(*Doryphora decemlineata*, Say.)

Order COLEOPTERA; family CHRYSOMELIDÆ.

The Colorado Potato-beetle is too well known to need extended comment. We may refer to our first, fourth, sixth, seventh, eighth, and ninth Missouri Reports, and to our Potato Pests, published by Orange Judd Company, New York, for full accounts of this insect. In treating of cabbage insects, however, the following paragraphs from the fourth report should not be omitted, though experience since has shown that the habit is quite exceptional, and that the cabbage-grower has nothing to fear from this insect:

NEW FOOD; CABBAGE.—It is a notable fact, and a most important one for us, that the Colorado Potato-beetle has in the past been found incapable of flourishing on any other plants but those of the nightshade family (*Solanaceæ*), and hitherto it has only been known to thrive upon the nightshade genus proper (*Solanum*), which includes the egg plant, the horse nettle, and some other wild species west of the Mississippi, such as *rostratum* and *cornutum*, which are known by various popular and local names. Upon the nettle (*S. carolinense*), which is common with us, but is mostly replaced in Kansas by the *S. rostratum*, it seems to delight even more than upon the potato, and I have found it quite injurious to other plants of the same genus, such as *warscewiczi*, *robustum*, *discolor*, and *sieglingæ*, which are often cultivated for their ornamental foliage. The other common plants of the family, such as the tomato (*Lycopersicum*), ground-cherry (*Physalis*), thorn-apple (*Datura*), henbane (*Hyoscyamus*), apple of Peru (*Nicandra*), tobacco (*Nicotiana*), belladonna, petunia, and cayenne pepper, are not over ch to its liking, though upon a pinch it will feed on all of them, and especially on the

first named. The cayenne pepper, if eaten to any extent, is actually poisonous to it, as we learn from Dr. Le Baron.

Under these circumstances it is an interesting fact (as showing how a new habit may be acquired under favorable circumstances) that last summer this insect was positively found feeding upon the cabbage, which is botanically so very distinct from the nightshade family. It would be sad indeed if so all-important an esculent should in the future be doomed to suffer, with the potato, from the insatiate appetite of such a pest, and I have no idea that cabbage-raisers need fear anything of the sort. Yet stranger things have happened, and certain it is that it was found devouring cabbages by Mr. H. H. McAffee, superintendent of the Wisconsin University Experimental Farm, while Miss Mary E. Murtfeldt, of Kirkwood, in whose testimony I can place the utmost reliance, found that in parts of Northern Illinois it did considerable injury to growing cabbages and was even breeding in great numbers upon them.

THE HARLEQUIN CABBAGE-BUG.

(*Murgantia histrionica*, Hahn.)

Order HETEROPTERA; Family SCUTELLERIDÆ.

[Plate IV; Fig. 2.]

PAST HISTORY.

In our Fourth Missouri Entomological Report (1871) we published an article upon this insect, from which the quoted passages in the following account are taken:

"Prior to the year 1870 the insect which forms the subject of this sketch was not known to occur in Missouri. It has of late years been gradually traveling towards us from the more southern States, and has already made its presence a little too manifest in some of our southern counties, and in Kansas I have met with it at a latitude higher than Saint Louis. It extends to Guatemala, and is found in Mexico; and it varies very much, as most species are found to do when their geographical distribution is studied. As it extends southward we find the dark colors predominating, and becoming more intensified and brilliant, and Stål has described a species (*Murgantia munda*) from Mexico, which is doubtless but a geographical race, since all the intermediate grades occur between it and the more northern form of *histrionica*. My friend Mr. P. R. Uhler has made some interesting experiments on the species, which have clearly proven that when reared in the dark the pale-red parts predominate; while if reared in the bright daylight the dark-blue colors predominate."

Spreading with great rapidity since the foregoing remarks were made, the Harlequin bug, or "Calico back," as it is called in some sections, reached as far north as Delaware in 1876, and is now found all over the Southern States. During the last three or four years it has quite seriously damaged the cabbage crop in limited localities in Maryland and farther south.

"The Harlequin Cabbage-bug derives its name from the gay, theatrical, harlequin-like manner in which the black and orange-yellow colors are arranged upon its body. The first account of the operations of this very pretty but unfortunately very mischievous bug appeared in the year 1866, from the able pen of Dr. Gideon Lincecum, of Washington County, Texas, and was printed in the Practical Entomologist (Vol. I, p. 110). His remarks are to the following effect:

"'The year before last they got into my garden and utterly destroyed my cabbage, radishes, mustard, seed-turnips, and every other cru-

ciform plant. Last year I did not set any of that order of plants in my garden. But the present year, thinking the bugs had probably left the premises, I planted my garden with radishes, mustard, and a variety of cabbages. By the first of April the mustard and radishes were large enough for use, and I discovered that the insect had commenced on them. I began picking them off by hand and tramping them under foot. By that means I have preserved my 434 cabbages, but I have visited every one of them daily now for four months, finding on them from thirty-five to sixty full grown insects every day, some coupled and some in the act of depositing their eggs. Although many have been hatched in my garden the present season, I have suffered none to come to maturity; and the daily supplies of grown insects that I have been blessed with, are immigrants from some other garden.

"'The perfect insect lives through the winter, and is ready to deposit its eggs as early as the 15th of March, or sooner, if it finds any cruciform plant large enough. They set their eggs on end in two rows, cemented together, mostly on the underside of the leaf, and generally from eleven to twelve in number. In about six days in April—four days in July—there hatches out from these eggs a brood of larvæ resembling the perfect insect, except in having no wings. This brood immediately begins the work of destruction by piercing and sucking the life-sap from the leaves, and in twelve days they have matured. They are timid, and will run off and hide behind the first leaf-stem, or any part of the plant that will answer the purpose. The leaf that they puncture immediately wilts, like the effects of poison, and soon withers. Half a dozen grown insects will kill a cabbage in a day. They continue through the summer, and sufficient perfect insects survive the winter to insure a full crop of them for the coming season.

"'This tribe of insects do not seem liable to the attacks of any of the cannibal races, either in the egg state or at any other stage. Our birds pay no attention to them, neither will the domestic fowls touch them. I have as yet found no way to get clear of them but to pick them off by hand.'"

NATURAL HISTORY.

The eggs of the Harlequin Cabbage-bug (Plate IV, Fig. 2, *c*, *d*, *e*) are very beautiful objects. They are about one-twentieth of an inch long by one-thirtieth wide, and are usually deposited in two parallel and closely applied rows of about half a dozen each. When first deposited they are green in color, but soon become white, with black markings. Their resemblance to miniature white barrels with black hoops is very marked, and the resemblance is heightened by a small black spot in the proper position for a bung-hole. The sides of the eggs which are applied to each other are almost entirely black. In oviposition the female moves her ovipositor in a zigzag manner from one row to the other.

The young larva in hatching cuts out the head of the barrel with its beak with the utmost neatness and precision. At first it is of a uniform pale-green color, marked with black, and with successive molts takes on certain orange markings. It differs from the adults in the scarcity of orange in its coloration, in the lack of wings, and in having but four joints to their antennæ, those of the adult having five joints.

Under favorable circumstances the rapidity of development of this insect is remarkable. The eggs will hatch on the third day after laying, and Mr. William R. Howard is authority for the statement that the young bugs will go through all their molts and be ready for reproduction within two weeks. They come early and stay late. In Virginia

they remain actively at work until November. They winter, as do all related insects, as full grown bugs under all sorts of rubbish, under stones, logs in fence-corners, around out-buildings, and in similar locations.

The preferences of this insect are for cruciferous plants, particularly cabbage and turnip, but it also injures mustard and radishes. We mentioned in our Fourth Missouri Report (p. 37) an instance of its having been found feeding on the garden pea in Missouri; and Mr. Lintner, in the *Country Gentleman* (Vol. XLV, 1880, p. 679), quotes a letter from a correspondent at Ivy Depot, Va., who states that after his cabbages and turnips had been destroyed, the bugs commenced to suck the bunches of late grapes and the shoots on some of his late corn, gathering in great numbers near the young silk.

The bugs are found in great numbers under favorable circumstances, so that the only hitherto successful remedy—that of hand-picking—becomes almost an unending task. One of our old correspondents, Mr. Benjamin R. Townsend, of Austin, Tex., wrote us in February, 1870, that he had within a few days gathered 47,000 of them, and when we consider that, according to Dr. Lincecum, half a dozen will kill a cabbage in a day, we get some idea of the vast amount of damage they are capable of doing.

The only natural enemy so far reported is the well-known *Leptoglossus phyllopus* of the Southern cotton-fields, and the evidence on which the belief rests is of the slightest. In Glover's MS. notes on the Hemiptera he quotes a correspondent, Mr. E. T. Earle, of Evergreen, Ala., as authority that the Leptoglossus kills the Murgantia. In our experience, however, the former is uniformly a plant-feeder, and is probably one of the causes of the mysterious decay and fall of cotton-bolls.

REMEDIES.

The ordinary poisonous applications have little effect upon this bug, and, indeed, experience shows that it is one of the most difficult species to contend with. In his first report as State Entomologist of New York, Mr. Lintner details an experiment in which he rolled specimens of the bug in London purple, Paris green, hellebore and pyrethrum powder, with no result except that those treated with the two last-named substances showed for a few hours some difficulty in locomotion. They soon recovered, however, and appeared perfectly sound and healthy. Both the hellebore and pyrethrum used in this experiment were said to be purchased fresh from the druggist; but we are of the opinion that had the latter been freshly ground and purchased from a wholesale rather than from a retail dealer, the result would have been more favorable.

Hot water will be found of good avail here, and also the plan of trapping the bugs under turnip or cabbage leaves laid on the ground, between the rows, as recommended (p. 299) for cut-worms. On cold nights in the spring and fall this latter remedy will be found particularly efficaceous.

Clean cultivation and burning of weeds and rubbish piles in winter will prove useful. We may also insist upon the point mentioned by Mr. Lintner, and often brought up by us in treating of other insects, of the great desirability of destroying, as far as possible, the early broods. This point should be especially urged in a case like the present one, where the insect multiplies with such extreme rapidity. The gardener should keep a constant watch upon his cabbages, and upon the first ap-

pearance of the young bugs, should either commence careful hand-picking at once or should begin the use of some one of the remedies just mentioned.

Finally, though we have had no opportunity of testing its value in this particular case, we have little doubt but that the kerosene emulsion will here also prove most satisfactory, as it has been found so effectual against other destructive species of the same sub-order.

THE TARNISHED PLANT-BUG.

(*Lygus lineolaris*, Beauv.)*

Order HETEROPTERA; Family CAPSIDÆ.

[Plate IV; Figs. 3, 4.]

HISTORY AND HABITS.

This very destructive plant-bug has long been known in this country. It is found all through the States, north, south, east, and west, and extends down into Mexico. Although it is so injurious to Cabbage that it cannot well be omitted from a treatise of this kind, yet it is only incidentally that it feeds upon this plant. It is, in fact, almost omnivorous. Harris states that during the very dry summer of 1838, especially in the early part, the gardens and fields of New England fairly swarmed with these little pests, which seemed to feed upon all kinds of herbaceous plants. They did great damage to the potato and other field crops, attacking the buds and terminal shoots and sucking out the sap, causing them to dry up and turn black. They also entered the flower gardens and injured the dahlias, marigolds, balsams, and asters. In our Second Missouri Report we called attention to the great damage done by these bugs to the apple, pear, plum, quince, cherry, and other fruit trees, by puncturing the buds and young twigs, and also spoke of the damage to cabbages and turnips.

Prof. A. J. Cook, in the *Michigan Farmer* of about July 15, 1876, mentions that the Tarnished Plant-bug had been doing considerable damage to the wheat and corn crops of Michigan, wheat in certain localities having been injured to the extent of 10 per cent. loss. He also stated that the previous year (1875) he had noticed it seriously injuring potatoes and currant-bushes at Owasso, Mich.

The statement in Glover's "Hemiptera" as to the carniverous habits of this bug are very misleading. In the first place he cites Le Baron as actually stating that it destroys the eggs of the Colorado Potato-beetle (*Doryphora decemlineata*); whereas Dr. Le Baron is really very doubtful about it, as he had only the testimony of a "Mr. Jos. Taylor, of Somo-

* SYNONYMY.—This species was originally described by Palisot de Beauvois as *Coreus lineolaris*, but by some mistake the specific name *linearis* was attached to the plate. Dr. Harris referred the species to the genus *Phytocoris* of Fallen, using the specific name *lineolaris*. In a foot-note to the Flint edition of Harris, Uhler, misled by Beauvois's plate, accuses Dr. Harris of misquoting in using *lineolaris* for *linearis*. Meantime it had been described by Say (ed. Le Conte, I, 340) as *Capsus oblineatus*. This name we adopted in the *American Entomologist*, I, 227, 276, 291, and II, 276; also, in our Second Missouri Report, p. 113, and in our Seventh Missouri Report, p. 26. Packard, following Uhler's foot-note, uses the name *Phytocoris linearis*, and Le Baron calls the species *Capsus linearis*. We learn from private correspondence with Mr. Uhler that it should be placed in the genus *Lygus*, and the species is given as *Lygus lineolaris* in Glover's Manuscript Notes, *Hemiptera*. Washington, 1876.

nauk," and, after discussing the matter, he concludes: "I am *inclined* to believe, after all, that Mr. Taylor's observations *may* have been correct." (Italics ours.) Glover's other citation of the carnivorous habits is even worse. He says: "The *American Entomologist* (I, 228) reports it as destroying the eggs of other insects." What was actually said in the *American Entomologist* is: "The mass of yellowish-white eggs deposited in close connection under the shriveled bark of such pear twigs as were poisoned and killed by the punctures of the olive-yellow bug (*Capsus oblineatus* Say) came duly to hand." Glover has of course taken our remarks concerning the punctured twigs as referring to the eggs. There is no evidence that the Tarnished Plant-bug is ever carnivorous. The following quoted passages are from our Second Missouri Report:

"Its puncture seems to have a peculiarly poisonous effect, on which account, and from its great numbers, it often proves a really formidable foe. It is especially hard on young pear and quince trees, causing the tender leaves and young shoots and twigs to turn black, as though they had been burned by fire. On old trees it is not so common, though it frequently congregates on such as are in bearing, and causes the young fruit to wither and drop. I have passed through potato fields along the Iron Mountain Railroad in May, and found almost every stalk blighted and black from the thrusts of its poisonous beak, and it is not at all surprising that this bug was some years ago actually accused of being the cause of the dreadful potato-rot.

"This bug is a very variable species, the males being generally much darker than the females. The more common color of the dried cabinet specimens is a dirty yellow, variegated as in the figure with black and dark brown, and one of the most characteristic marks is a yellow V, sometimes looking more like a Y, or indicated by three simple dots on the scutel (the little triangular piece on the middle of the back behind the thorax). The color of the living specimens is much fresher, and frequently inclines to olive-green. The thorax, which is finely punctured, is always finely bordered and divided down the middle with yellow, and each of the divisions contains two broader longitudinal yellow lines, very frequently obsolete behind. The thighs always have two dark bands, or rings, near their tips.

"As soon as vegetation starts in the spring, the mature bugs which winter over in all manner of sheltered places may be seen collecting on the various plants which have been mentioned. Early in the morning they may be found buried between the expanding leaves, and at this time they are sluggish, and may be shaken down and destroyed; but as the sun gets warmer they become more active, and, when approached, dodge from one side of the plant to the other, or else take wing and fly away. They deposit their eggs and breed on the plants, and the young and old bugs together may be noticed through most of the summer months. The young bugs are perfectly green, but in other respects do not differ from their parents except in lacking wings. They hide between the flower-petals, stems, and leaves of different plants, and are not easily detected. Late in the fall none but full-grown and winged bugs are to be met with, but whether one or two generations are produced during the season I have not fully ascertained, though in all probability there are two."*

Since this article was prepared, this bug has been detected in a new habit that has proved quite serious to strawberry-growers in Southern

*George F. Gaumer, in the *Kansas Farmer* of November 10, 1876, states definitely that there are two broods in Kansas.

Illinois. It punctures the young or green fruit, causing what is known among strawberry-growers as "buttoning," *i. e.*, a partial or even complete drying and hardening of the berry. Professor Forbes, in his last report on the Insects of Illinois (Thirteenth Report of the State Entomologist), devotes an extended article to this insect, among the other species treated of as injuring the Strawberry, and indulges in some criticisms of the statements of previous authors in reference to the poisonous effects of the puncture of the bug, as indicated in the passage from our previous writings which we have quoted (p. 313). Based on statements of Mr. D. B. Wier, of Lacon, Ill., and on his own observations of the effects of the bug on strawberries, he discredits its poisonous influence, remarking that it would require "the very strongest evidence to warrant a belief in so extraordinary a phenomenon." He further argues:

"It is contrary to the order of nature that a habit of this sort should be acquired, unless it were beneficial, directly or indirectly, to the species acquiring it. It is not only impossible to show that the plant-bug would be benefited by any such supposed poisoning of its own food, but it is at once evident that it would be seriously injured thereby, since this would at once amount to the prompt destruction of the very parts of the plant from which it was drawing its own food supply."

Our own evidence, and that of Harris and others whom we might quote, is rejected on the gratuitous supposition that we were not sufficiently familiar with the common blights of fruit trees to distinguish between them and the effects of this insect, and that Harris was equally ignorant of the appearance of the potato-rot and confounded it with the work of this bug. We feel confident of the correctness of our own observations, however little the poisonous effect may be apparent in other cases, and we venture to suggest that the peculiar "buttoning" of the strawberry, now admittedly produced by this insect, is very good confirmation of a poisonous and withering influence, as all analogy would indicate that no such peculiar result would follow from a simple, innocuous puncture, whether by an insect or by some delicate instrument. The general argument of its being "contrary to the order of nature," &c., seems to us to be without force; for, on such grounds, it would be difficult to account for any injurious insect's work that jeopardizes the welfare or life of the plant which it injures. It is like arguing that the poisonous effect of a mosquito puncture must be a myth because the irritation so often results in the death of the irritator, and because it is known that other Diptera puncture still more sharply without poisonous effect. We recognize the general application of the law referred to by Prof. Forbes; but it is by no means of universal application, and has little force against a general feeder like this Lygus. The history of natural science furnishes numerous instances of erroneous conclusions deduced from general law as against inductive fact, and on Prof. Forbes's reasoning it were impossible to account for the development of any poisonous influence (as the sanguinary taste of Leptus, the deadly effects of minute micro-organisms, etc.), and all parasites should, like the mythical vampire, do their work without irritation, or, for that matter, without ill effect. Indeed, the argument would be unworthy of further notice were it not intended to invalidate the observations of others.

REMEDIES.

"In the great majority of cases we are enabled to counteract the injurious work of noxious insects the moment we thoroughly comprehend

their habits and peculiarities. But there are a few which always defy our efforts. The Tarnished Plant-bug belongs to this last class, for we are almost powerless before it from the fact that it breeds and abounds on such a great variety of plants and weeds, and that it flies so readily from one to the other. Its flight is, however, limited, and there can be no better prophylactic treatment than clean culture, for the principal damage is occasioned by the old bugs when they leave their winter quarters and congregate on the tender buds and leaves of young fruit stock; and the fewer weeds there are to nourish them during the summer and to protect them during the winter, the fewer bugs there will be. The small birds must also be encouraged. Applications of air-slaked lime and sulphur have been recommended to keep them off, but if any application of this kind is used I incline to think that, to be effectual, it must be of a fluid nature, and should recommend strong tobacco-water, quassia-water, vinegar, and cresylic soap. * * * I have noticed that the bugs are extremely fond of congregating upon the bright yellow flowers of the cabbage, which, as every one knows, blooms very early in the season, and it would be advisable for persons who have been seriously troubled with this bug, and who live in a sufficiently southern latitude where the plant will not winter-kill, to let a patch of cabbages run wild and go to seed in some remote corner of the farm, in order that the bugs may be attracted thither and more readily destroyed than when scattered over a larger area."

In addition to the suggestions in the foregoing quotation, we have, fortunately, much more effectual and satisfactory remedies that have come into use since that was written. Professor Forbes, in the elaborate article already alluded to, shows quite conclusively from a series of experiments that Pyrethrum is perfectly effective as an agent in destroying this bug; and, further, that the kerosene emulsion, while not satisfactory if too weakly diluted, is an effective remedy and will be found available for field use if sprayed in dilution containing not less than 5 per cent. of kerosene.

THE FALSE CHINCH-BUG.

(*Nysius angustatus* Uhler.)

Order HETEROPTERA; Family PHYGADICIDÆ.

[Plate V; Fig. 2.]

PAST HISTORY AND HABITS.

In the *Western Planter* for June 29, 1872, we published the first notice of this insect. In *Phillips' Southern Planter* of about September 1, 1872, Mr. William R. Howard published a rather meager description of it under the name of *Nysius raphanus* n. sp. This was copied in the *Country Gentleman* for September 15, and appeared in the *Canadian Entomologist* for November, 1872. In our Fifth Missouri Entomological Report, published April 18, 1873, we gave a more extended description under the name *Nysius destructor* n. sp., abandoning the name *raphanus* at the author's request, but stating at the same time that the species is so variable "that it is difficult to see wherein some of the specimens differ from the European *thymi*, or from *N. angustatus* Uhler, and it is barely possible that future comparison will show specific identity be-

tween some or all of the three." Mr. P. R. Uhler, our best authority, at that time considered it distinct, however, but has recently, in a letter to Prof. S. A. Forbes (13th Rep, Ins. Ills., 1884, p. 105) justified our earlier impression by concluding that *destructor* is a synonym of *angustatus.*

In the False Chinch-bug we have again a very general feeder and a very injurious insect. We first learned of its injuries in May, 1872, when it was sent us from Clarksville, Mo., as damaging grape-vines. We have since either found it or had it reported on strawberry-plants, young apple-grafts, potatoes, turnips, radishes, beets, cabbages, lettuce, purslane, and mustard. Professor Forbes treats of it as a strawberry enemy, but it seems to prefer cruciferous plants and to avoid the cereals. As a cabbage insect it was particularly injurious at Manhattan, Kans., in 1873, as we were informed by Mr. Thomas Wells, of that place. On potatoes it is especially injurious. At some of the fall meetings (1872) of the Meramec (Missouri) Horticultural Society complaints were made of a new habit which the Chinch-bug had of injuring potato-vines, and of crowding on the tubers and injuring them after they were dug. The False Chinch-bug was undoubtedly the insect observed. The popular name of "False Chinch-bug" was adopted from the fact that we frequently received this species from correspondents, who sent it under the supposition that it was the true Chinch-bug.

"In common with all other true bugs, this insect feeds by suction, and the way in which it injures a plant is by depriving the same of its juices and causing it to wilt. Potato-leaves sent me by Mr. Stone (of Kansas City, Mo.) presented the appearance of Plate V, Fig. 2, *a*, showing little, rusty, circular specks where the beak had been inserted, and little irregular holes, which looked more as if made by some flea-beetle, one of which, the Cucumber Flea-beetle (*Haltica cucumeris* Harr.), is known to thus injure potato-leaves."—(Fifth Rep. Ins. Mo., p. 112.)

The young wingless bugs are of a paler color than the adults, with more or less distinct longitudinal dark lines on the head and thorax. The pupa (Plate V, Fig. 2, *b*) has the front part of the body marked with more distinct red and brown lines, with the abdomen paler, and with longitudinal pinkish mottlings. When occurring in force these bugs will crowd on a plant as long as there is room for them, and, sucking its sap, soon cause it to wilt and die. They are active and readily take alarm, the winged individuals arising in swarms when disturbed. In early morning, however, they are more sluggish and hide in wilted leaves. Wet weather, as with the true Chinch-bug, is extremely unfavorable to their development.

The number of broods in the course of a year has not yet been determined, but, from analogy, there are probably two or three, and the insect hibernates mainly in the perfect state under all sorts of rubbish. Late in the fall of 1872 we found them very abundant in all stages, collecting under purslane, and they doubtless make frequent use of this spreading and close fitting weed for winter-quarters. Mr. Thomas Wells, of Manhattan, Kans., thinks that the insect breeds only where the purslane grows. The eggs have not yet been observed or described.

REMEDIES.

The best preventive of the injuries of this insect will be found to consist in clean cultivation, which we have so strongly urged in the case of the true Chinch-bug. We have shown that, like the latter, it winters under all sorts of field rubbish, and the careful burning of old weeds

and trash will undoubtedly much lessen its numbers. This is, in fact, almost the only practical method of fighting it. Mr. Howard states that the application of lime has been tried to some extent, but seemingly without result. On account of the habit which the bugs have of clustering in shriveled-up leaves in the morning when the dew is on the plants, he advises going through the garden or field with a pail containing live coals, into which such leaves are dropped after plucking them off. In small gardens the adoption of this remedy might pay, but we would advise the substitution of water with a film of kerosene on its surface for the live coals. Fortunately, however, we have available two insecticides that had not come into use when we first wrote on this insect. These are pyrethrum and kerosene emulsion, which, as we have already seen, Professor Forbes found perfectly satisfactory as against the Tarnished Plant-bug (*Lygus lineolaris*, Beauv.), and which we do not hesitate to advise to be used in the same manner against the False Chinch-bug, which, in habit and characters, is so closely related to the species experimented on.

THE CABBAGE PLANT-LOUSE.

(*Aphis brassicæ* Linn.)

Order HOMOPTERA; Family APHIDIDÆ.

[Plate VII; Fig. 4.]

PAST HISTORY AND HABITS.

The Cabbage Aphis is without much doubt an imported insect. Fitch shows, by reference to the Transactions of the New York State Agricultural Society for 1791, that it was already known in this country at that early date, and states that it was probably introduced shortly after the cabbage-plant itself was brought over. In Europe, as in this country, it occurs commonly on the turnip, radish, field cress (*Isatis tinctoria*) shepherd's purse (*Capsella bursa-pastoris*), and charlock (*Brassica arvensis*), in addition to cabbage, and upon this last plant, according to Buckton, "it often crowds both the upper and under sides of the foliage in such numbers that the leaves become hidden by the living mass. Indeed, sometimes, weight for weight, there is more animal than vegetable substance present. The leaves then become putrid, offensive in odor, and quite disgusting to the eye."* This is a common sight in this country also, and frequently whole fields of cabbage are rendered unfit for the market by the work of this species.

It abounds in all parts of the country where the Cabbage is cultivated, from Northern New York to Southern Georgia, and were it not for its numerous natural enemies it would rank as the most serious of the insect foes of this plant.

It is found upon the under side of the loosened outer leaves of the cabbage, or upon the upper side of the compacted inner leaves, either wandering about singly or settled in large groups. It makes its appearance in June or July, and remains until cold weather. Late in October, 1871, we noticed great numbers of this aphis flying in the city of Saint Louis, filling the air in every direction and flying into people's

*Monograph of the British Aphides, II, 34.

eyes and ears. The weather had been very warm previously, and as late as the middle of November the plants in the turnip-fields around the city were swarming with the lice.

LIFE HISTORY.

Common as the insect is, its life history has not been fully worked out. But two forms have been observed by Buckton and Thomas—the winged and the wingless viviparous females. Curtis described what he took to be the winged male, but from his description it is evident that he mistook all winged females for males. Fitch follows him in this error, in that he uses the following sentence taken almost word for word from Curtis without credit to that author: "In August, September, and October the old wingless females are seen, resting stationary, with their bills inserted into the leaf, pumping out its juices, surrounded by their young brood all similarly employed, with here and there a *winged male* walking lazily about over the backs of his kindred." After this statement Fitch recognized Curtis's mistake, and says: "The winged individuals, Mr. Curtis takes it for granted, are males; but they certainly are, at least for the most part, females, and show the tip of the ovipositor slightly projecting, like a tail, from the end of the body. So we may safely say that neither the male nor the oviparous female is known.

The wingless viviparous female has a rather long oval body, covered with a whitish mealy coat. When this coat has been removed by immersion in alcohol or otherwise, the body is seen to be of a grayish-green color, with eight black spots down each side of the back, increasing in size towards the posterior end. The antennæ are green, with black tips, and are shorter than the body, and the eyes, legs, and tail are black. (Pl. VII, Fig. 4, *b*.)

The young when first hatched are oval, shining, bright yellow in color, and lack the mealy coat.

The winged viviparous female is yellowish-green, with the eyes, head, neck, and thoracic lobes black, and the antennæ and nectaries dark brown. The legs are dusky-brown and hairy; the tail is dark-green or brown and also hairy; the wings are rather short, with stout, coarse veins and dark stigma. (Pl. VII, Fig. 4, *a*.)

NATURAL ENEMIES.

Concerning the European natural enemies of the Cabbage Aphis, Buckton says (*ibid.*): "Several species of Syrphidæ and Ichneumonidæ act effectively as checks upon the increase of *A. brassicæ*. The larvæ of the former Dipterous flies, living in the midst of such plenty, soon gorge themselves and become of great size. Amongst the latter Hymenopterous parasites may be mentioned several genera of aphidivorous Ichneumons, as *Ceraphron*, *Trionyx*, and *Coruna*. A common form is a fly, which appears to be *Trionyx rapæ* Curtis. In September, often nine-tenths of a colony will be struck by this parasite, the aphides, instead of passing from their pupa state into the imago, will turn brown and hard from the deadly action of the grub, which solitarily inhabits each individual."

Similarly in this country we have many natural enemies of this aphis, and among them an Ichneumonid, which is very closely allied to and almost identical in appearance with the *Trionyx rapæ* just mentioned.

(See Curtis' Farm Insects, p. 71.) This parasite was received at the Department February 27, 1880, from Norfolk, Va., and was described as *Trioxys piceus* by Mr. Cresson in the Annual Report of this Department for 1879, page 260. This same parasite was bred by us at Saint Louis as long ago as 1871.

REMEDIES.

The remedy of fumigation with tobacco smoke, as recommended by Fitch, Curtis, Thomas, and others, is impracticable on a large scale, and applications of soot, ashes, lime, and washes of tobacco-water and other materials seem ineffectual. Strong whale-oil soap solution, indeed, seems to be the only remedy so far tried which affords any satisfaction. This is highly recommended by Prof. W. R. Lazenby, formerly of the Horticultural Department of Cornell University. Taschenberg (Naturges. d. wirbellosen Thiere) recommends sprinkling with soap-suds treated with quassia, and also the use of a decoction of fresh walnut leaves.

Here, again, the pyrethrum infusion will destroy a large number of the insects which work in such exposed situations that they can be easily reached by a spray, while the waxy material which they excrete is not sufficiently abundant to perfectly shed a watery solution, as is the case with many allied species. But the kerosene emulsion will prove more satisfactory than any of the other insecticides mentioned.

THE CABBAGE ANTHOMYIA.

(*Anthomyia brassicæ* Bouché.)

Order DIPTERA; family ANTHOMYIDÆ.

[Plate VIII; Fig. 5.]

PAST HISTORY; HABITS.

The Cabbage Fly has only been positively known in this country, so far as we can ascertain, since 1856, and was in all probability introduced from Europe at some date prior to this, as there seems to be no doubt but that our species is identical with the European *Anthomyia brassicæ* of Bouché.* Curtis has given accounts of the insect and its habits in the *Gardeners' Chronicle* and in his Farm Insects, and Taschenberg has treated of it in his Naturgeschichte der wirbellosen Thiere. In this country Fitch gives a good account of it in his Eleventh Report on the Insects of New York (1867), and it has received some attention from writers in the different agricultural periodicals. Mr. Lintner has also written at length upon the species in his First Report as State Entomologist of New York (1883).

According to Fitch, the maggots were very abundant and destructive in New York State in 1856 and 1857, infesting turnips and rutabagas as well as cabbages. There can be little doubt but that the work of these larvæ is one of several causes of "club-root" in cabbage. Appearing in spring, the flies deposit their eggs upon the stems at or near the

* This species is considered by Schiner and others as a probable synonym of *A. ruficeps* Meigen.

surface of the ground. The maggots, hatching, work their way downwards and feed upon the root, sometimes simply grooving the bark, but more often boring into the interior. Frequently they are so numerous that many of the young plants are killed outright; again, however, they simply check the growth and cause the malformation of the root, known as "club-root," when the leaves take on a yellowish hue and the plant wilts at noonday. Curtis says: "On pulling up the stalks of some cabbages recently cut, I found the roots enlarged, lumpy, and carious, and, on opening them, they were hollow, with the maggots of the Cabbage-Fly, full-grown, in cavities." Of course by far the greatest damage is done to the young plants, which are less able to stand the constant drain upon their vitality. The work of these maggots upon turnips is well described by Fitch, as follows:

"These maggots infest the turnip and rutabaga also, mining an irregular burrow in the interior, or inhabiting eroded spots upon their outer surface. Sometimes a small roughened spot is seen, appearing like a crack in the skin of the turnip, with its edges rough and ragged and turned outward, and on paring off this roughened spot a plump white maggot is come upon, lying in a cavity it has made there for itself. At other times a large, eroded spot occurs, which is filled with wet and slimy dirt. On removing this dirt the surface is found to be rough and warty, with little grooves here and there, in each of which is a maggot. Sometimes, also, a maggot is seen with only its anterior end imbedded in the turnip, leaving a third or half the length of its body projecting out therefrom."

The number of broods in the course of a season has not been accurately followed in any given latitude, but there are at least three, and the insect hibernates both in the larva state in the roots and in the puparium state underground. According to Curtis, the adult flies also, doubtless, hibernate in cracks and crevices. Taschenberg states that there are annually three generations in Germany, and that both the flies and pupæ hibernate. Our first acquaintance with this insect was in June, 1867, when Prof. A. N. Prentiss, then at the State Agricultural College, Lansing, Mich., sent us specimens of the larvæ, with an account of their gnawing and excoriating both the stems and roots of cabbages, and thereby doing much damage. They transformed June 21–25, just below the surface of the ground, to puparia (Plate VIII, Fig. 4, *b*) of a honey-yellow color, some lighter, some darker, and the first flies issued June 29 onward. We have since (in 1878) found the species not only working in the normal way in the roots, but also burrowing in the stout midribs of the leaves. From June 8–13 quite a number of the perfect flies were obtained.

NATURAL ENEMIES.

Bouché has reared the parasitic *Alysia manducator* Panzer from the larvæ of several Anthomyians, but, so far as we are aware, no similar parasites have been reared from the species in this country. The Staphylinid beetle—*Aleochara anthomyiæ*—has been bred by Mr. P. S. Sprague, at Boston, from the puparium of *A. brassicæ* and published by him as a true parasite (*American Entomologist*, Vol. II, pp. 302, 370). More recently Dr. W. S. Barnard (*ibid.*, Vol. III, p. 99) has given an interesting account of the occurrence of this species at Ithaca, N. Y., but he gives no evidence of other than predaceous habits on the part of the adults.

REMEDIES.

The remedies which have thus far been proposed may be summed up as follows:

Dip the roots, as the young cabbages are transplanted, in oil or lye of ashes. (Bouché.)

Pull up and remove infested plants on the first symptoms of insects at the roots. Carry them away and burn them and fill up the hole from which they were removed with brine or lye of ashes. (Curtis.)

"In other instances where the maggots have made great havoc with the cabbages, cauliflowers, and broccoli, gardeners have collected large quantities of the brown pupæ from the roots with the hope of checking their increase; and as the transformations of the insect are in rapid succession, it must have a good effect." (Curtis).

Apply salt to the field at the rate of 86 bushels per acre and mix with surface 4 inches deep. Also water the plants with mixture of one gallon soapsuds to one gallon of gas-water. Beware of fresh, unrotted manure; use none that is not thoroughly rotted. (Curtis.)

Sift powdered tobacco on the leaves as a preventive.

P. T. Quinn, in his Money in the Garden, states that he offered $100 for a remedy for the maggot, and received a large number in reply. Those which gave the best results were, dusting the roots of the cabbages with fine bone-dust, and the application of one teaspoonful of caustic shell-lime to each plant, first "removing a little earth from around the stem, putting on the lime, and then replacing the soil."

Taschenberg gives a remedy taken from the Bulletin de la Société Impériale des Naturalistes de Moscou, XVIII (1855), No. 3, which is to scatter coal dust around the roots of the majority of the plants in the field, leaving here and there a plant untouched. The flies in laying their eggs avoid the spots where the coal dust lies and seek out the unprotected plants, which will thus act as traps, since they can at the proper time be pulled up and the maggots and pupæ at the roots destroyed. This seems to us the most rational remedy yet proposed, and we have no doubt but that it can be used with good results. Slaked lime or ashes can undoubtedly be substituted for the coal dust (Kohlenpulver) mentioned by Taschenberg.

It is certain from the statement of European observers that this species winters largely in the pupa state, therefore late fall plowing will prove a partial preventive. Since it seems highly probable that many of the larvæ also hibernate, the pulling up and burning of the stalks and roots, after the cabbages have been cut, is much to be recommended.

Since the use of bisulphide of carbon against the root-inhabiting form of the Grape Phylloxera, we have recommended it for all root-feeding insects, and that it is satisfactory against this Cabbage Anthomyia is proved by the experiments of Prof. A. J. Cook in 1880.* A small hole is made in the earth near the main root of the plant by forcing in a small stick, and about one-half a teaspoonful of the liquid is poured in, when the hole is quickly filled in with earth, which is pressed down with the foot. In every case the insects were killed without injury to the plants. In the use of this substance the extreme inflammability of its vapor must be remembered, and where much of it has to be used in the ground a good injector should be obtained, like the Gastine injector so commonly used for the purpose in France. As a safer and simpler remedy we strongly recommend the kerosene emulsion.

*_American Entomologist_, Vol. III, p. 264.

THE CABBAGE OSCINIS.

(*Oscinis brassicæ* n. sp.)

Order DIPTERA; Family OSCINIDÆ.

[Plate VIII, Fig. 5.]

On June 17, 1876, we noticed that in the vicinity of Saint Louis certain cabbage-leaves were mined by the larvæ of some insect. Upon opening the mines, however, nothing was found but a number of Hymenopterous pupæ, undoubtedly of parasites upon the original miner. A few days later the mining larva was found. It was Dipterous, pupated underground, and a single fly was bred June 30. In 1882 (June 25) the same insect was found mining cabbage-leaves in Georgetown, D. C. At this time the larvæ were all full-grown and pupated two days later, about a quarter of an inch under the surface of the ground, where all the specimens died. The mine is an irregular pale trail, ranging from 0.5^{mm} to 2^{mm} in diameter, often turned on itself and coalescing to form irregular patches and with dark excrementitious points. The miner is a light yellowish-green maggot with black mouth-parts.

Although this insect seems rare at present, it may at any time become sufficiently numerous to prove injurious, and it is well to study it in advance. It seems closely related to the Clover Oscinis (*Oscinis trifolii* Burgess) treated in the Department Report for 1879. As will be seen from the above notes, we have no knowledge of the number of broods, but, judging from analogy, there are probably at least three annual generations, and the insects winter underground in their puparia.

DESCRIPTIVE.

OSCINIS BRASSICÆ n. sp.—Closely resembles *Oscinis trifolii* Burgess. Differs only in the following particulars: The eyes are narrowly margined with black, the border at apex being pronounced and wide. The scutellar spots are narrow, not so wide as in *trifolii*. Abdomen yellow only on venter, not margined with yellow. Middle and hind tibiæ pronouncedly fuscous. Third and fourth wing-veins more widely divergent than in *trifolii*.

Described from 1 ♀, June 30, 1876, Saint Louis, Mo.

Larva.—Length of full-grown larva 4.19^{mm}, width of penultimate joint 0.9^{mm}. Color light yellowish-green. Skin nearly smooth, the raised junctures of the segments each marked with from 6 to 12 transverse lines of minute granulations. The head is difficult to observe, as it is usually withdrawn with the prothoracic joint into the meso-thoracic joint. It is pointed anteriorly, and the characteristic black rake, with its eight teeth, forming the mouth-parts, is plainly seen even when the head is entirely telescoped. The prothoracic spiracles are mounted on short, stout tubercles, which are proportionately smaller than those of *trifolii*. The anal joint appears very bluntly rounded, not sharply and obliquely truncate as with *trifolii* and *malvæ*. The anal spiracles are mounted on long, slender papillæ, directed backwards and parallel with each other. The penultimate joint bears four very stout, conical, tubercles directed posteriorly, two of which are subdorsal and two sublateral; also two smaller, subventral tubercles. The anal joint can be drawn partially within the pre-anal, and when its protruding papillæ are added to the large tubercles of the latter joint the posterior end of the body seems to fairly bristle with points.

Puparium.—Length 2^{mm}. Broadly oval seen in dorsal profile; convex above and flattened below. Color, brown when living and nearly white after the fly has issued. The prothoracic and anal spiracles project at either end, but are not so prominent as with *trifolii*. The skin is smooth, and but ten joints show.

THE ROCKY MOUNTAIN LOCUST.

(*Caloptenus spretus* Uhler.)

Order ORTHOPTERA; Family ACRIDIDÆ.

This omnivorous insect naturally does not neglect Cabbage when the opportunity offers, and we have mentioned it as one of the food-plants of this species in our Seventh Missouri Report. For a full account of this insect we refer the reader to the First and Second Reports of the United States Entomological Commission and to our last three Missouri Reports.

SUCCESSFUL INTRODUCTION OF A PARASITE OF THE IMPORTED CABBAGE WORM.

In our last Annual Report, while speaking of the parasites of the Imported Cabbage Worm (*Pieris rapæ*), we considered the question of the importation of one of the commoner European parasites, viz., *Apanteles glomeratus*, Linn., recounting our former efforts, and also those of Mr. Otto Lugger, of Baltimore, to introduce and colonize it. From all we can learn from the letter received from Mr. Lugger, his effort proved unsuccessful. We now have the pleasure of recording the successful introduction of the species in the vicinity of Washington. We received during the past winter a number of cocoons from Mr. G. O. Bignell, of Plymouth, Eng., a portion of which had already given forth the perfect flies, but a large number of which still contained the pupa. The flies began to come out during the early spring, and on the 23d of April last we had liberated 45 specimens of both sexes in a cabbage field at the Soldiers' Home. We also left instructions to have others liberated from time to time, as they issued, after our departure for Europe, and finally, in May, a number of cocoons were placed upon one particular cabbage plant.

It was with no small degree of pleasure that during the fall, upon revisiting the same cabbage field in November, two masses of cocoons were found, with the shrunken larvæ which the insects had preyed on, many rods away from those deposited in May. From some of the cocoons found in autumn the flies were obtained, and proved to be, as the cocoons indicated they would, the very same *Apanteles glomeratus*. Thus we have absolute proof of the successful introduction and propagation of the species, and we may expect to hear of its discovery from year to year at points more and more remote from the place of introduction.

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*GENERAL TRUTHS IN APPLIED ENTOMOLOGY.**

Mr. President and Gentlemen of the Georgia State Agricultural Society:

On your programme I am booked for an essay on "Insects Destructive to Southern Agriculture." Your worthy secretary, Mr. Grier, is responsible for that title, for I had no idea what it was to be till the circular was received, on the very day of my departure from Washington. In

* An address delivered February 12, 1884, by C. V. Riley, before the Georgia State Agriculture Society at its annual meeting in Savannah.

the mean time, in pondering the question what to present to you, I concluded it were better, perhaps, to state some general truths of universal application than to attempt to treat of the different species of injurious insects, which the members of this society must be interested in—coming, as they do, from all parts of a State with such vast and varied agricultural interests. Hence, the hasty notes which I shall present are not worthy to be called an essay, and if they must have a title, would better reflect some "General Truths in Applied Entomology." It will, however, afford me great pleasure at the close to give more specific information in answer to any questions that may be asked.

Insects play a most important part in the economy of nature. The average townsman, whose knowledge of them is confined to certain lectual and household pests, can scarcely appreciate the fact or have any other feeling than repugnance and contempt for the annoying hexapods of his acquaintance. Yet, as scavengers, as pollinizers of our flowers and fruits, or as food for other animals, they not only vitally concern man, but, philosophically considered, are seen to be essential to his very existence.

We receive, also, some direct benefits from insects. They supply us with the sweetest of sweets, our very best inks and dyes, and our finest robes and tapers, to say nothing of various acids, lacs, and waxes; while few, who have not studied the subject, have any just idea of the importance of insects and their products as articles of human diet.

But the benefits, whether direct or indirect, which man derives from insects, must always appear trifling compared to the injury they inflict on our agriculture.

In the primitive condition of the country, as the white man found it, insects, doubtless, took their proper place in nature's economy, and rarely preponderated in any direction to the injury of the wild plants scattered, for the most part, sparsely throughout their range. Harmony between organisms, in the sense of the widest inter-relation and inter-dependence, had resulted in the long course of ages. But civilized man violated this primitive harmony. His agriculture, which is essentially the encouragement and cultivation, in large tracts, of one species of plant to the exclusion of others which he denominates weeds, gave exceptional facilities for the multiplication of such insects as naturally fed on such plants. In addition to this inevitable increase of species thus encouraged, many others have been unwittingly imported from other countries, chiefly through the instrumentality of commerce with those countries; for it is a most significant fact that the worst weeds and the worst insect pests of American agriculture are importations from Europe. Thus, in addition to the undue increase of our native species, as above noted, we have to contend with these introduced foreigners, and it is no wonder that Dr. Fitch declared America to be the land of insects, for, as compared to Europe, we are truly bug-ridden.

As I have stated (Encyclopædia Americana: Agricultural Entomology): "The losses occasioned by insects injurious to agriculture in the United States, are, in the aggregate, enormous, and have been variously estimated at from $300,000,000 to $400,000,000 annually. It will never be possible to fully protect our crops from the ravages of the many species that injuriously affect them; but it is the aim of the economic entomologist to prevent as much of the loss as possible and at the very least expense. To do so effectually, the chief knowledge required is of an entomological nature, *i. e.*, the full life-history and habits of the different species; and this implies a great deal of close and accurate work in field and laboratory. By means of it we learn

which species are beneficial, and which injurious; and the ability to distinguish between friend and foe is of the first importance in coping with the latter, for it is a notorious fact that the farmer often does more harm than good by destroying the former in his blind efforts to save his crops.

"A great deal has been written and published of late years on the subject of economic entomology, much of it, however, at second hand; for, unfortunately, the original workers are few. That comparatively small progress has hitherto been made, is due to this last fact, as well as to the intricacies and complex nature of the subject. The economic entomologist, to do effectual work, must possess, not merely a knowledge of the particular injurious species, and its habits, with which he wishes to deal, but must study its relations to wild plants as well as to the particular cultivated crops it affects. He must also study it in its relations to other animals. Indeed, its whole environment must be considered, especially in connection with the farmer's wants, the natural checks which surround it, and the methods of culture that most affect it. The habits of birds, the nature and development of minute parasitic organisms, such as fungi, the bearing of meteorology, must all be considered, and yet, with the knowledge that a study of all these bearings implies, he will frequently fail of practical results without experiment and mechanical ingenuity."

The earlier writers on applied entomology, as Peck, Harris, Fitch, Walsh, Le Baron, Glover, did good work in unraveling the life mysteries of injurious species, and framed their advice to the cultivator from these entomographic studies. Mere study of this kind alone, however, while essential, is not often productive of those important practical results which follow when it is combined with field work and experiment by competent persons and upon scientific principles. Many of the remedies proposed and recommended in the agricultural press are either ridiculous or else based on misleading empiricism, and economic entomology, as a science, is of comparatively recent date.

The time-limit of this paper will permit but the briefest reference, by way of illustration, to some of the means alluded to. I have already indicated the prime importance of a knowledge of the life-history of the species to be dealt with—a knowledge that can come only by direct and careful inductive research carried on sometimes during many years; for every insect exists, in the course of its development, in four different states, three of them more or less abruptly marked by metamorphosis and each with habit and environment peculiar to it. Thus the same species may inhabit earth, air, and water at one or the other period of life, and yet be quite incapable of a change of environment at any one period. It took me five years, with a number of observers at command, to definitely settle some points in the life-history of the Cotton-worm (*Aletia xylina*, Say), and with all the resources of the French Government—its liberal premium, its superior and sub-commissions appointed for the purpose and at work for the past fifteen years—there is much that is yet mooted in reference to the Grape Phylloxera. You have all heard of this insect, and perhaps a brief statement of its habits will serve to illustrate the complicated problems with which the economic entomologist often has to deal. I quote in substance from one of my reports:

"The full life-history of the species exhibits to us no less than five different kinds of eggs. 1. The regularly ovoid egg, 0.25^{mm} long and half that in diameter, of the normal, agamic, and apterous female, as it is found upon the roots. 2. The similar but somewhat smaller egg of

the gall-inhabiting mother. 3. The female egg from the winged mother, rather more elliptical and 0.4^{mm} long when matured. 4. The male egg from same, $\frac{1}{4}$ less in length and rather stouter. 5. The impregnated egg 0.32^{mm} long, still more ellipsoidal and with peculiar sculpture and anal point. We have also the peculiar spectacle of an egg from the winged mother increasing from 0.34^{mm} (its size when laid) to 0.4^{mm} (its size just before hatching), giving birth to a perfect insect 0.4^{mm} long, and this without any nourishment, laying an egg 0.32^{mm} long. A being thus born, and without food whatsoever, lays an egg very nearly as large as that from which she came.

"We have, further, the spectacle of an underground insect possessing the power of existence even when confined to its subterranean retreats. It spreads in the wingless state from vine to vine, and from vineyard to vineyard, when these are adjacent, either through passages in the ground itself or over the surface; at the same time it is able in the winged condition to migrate to much more distant points."

The recent advance in our knowledge of the life-history and habits of species has been great, but leaves yet an immense field for future research.

Insects probably outnumber in species all other animals combined, some 350,000 having already been described, and fully as many more remaining yet to be characterized. The proper and conscientious characterization of a genus or species of some microscopic creature involves as much labor as that of one of the higher animals. Of the above number a goodly proportion are injurious to cultivated crops. Lintner recently records no less than 176 affecting the Apple.

Of insecticides any number of substances have been recommended and many of them tried with more or less satisfaction. Of these may be mentioned lime, sulphur, soot, salt, wood-ashes, corrosive sublimate, naphtha, naphthaline, turpentine, alum, carbolic acid, phenyle, cyanide of potassium, blue vitriol, ammonia, alkalies, benzine, vinegar, sulphuric acid, quassia, vitriol (the sulphate of copper), hot water, &c. Most of these may be successfully used for specific purposes, either dry, in liquid, or in vapor; but the three most useful insecticides of general application in use during the early days of economic entomology in this country and up to within a few years, were undoubtedly tobacco, white hellebore, and soap. Tobacco-water and tobacco-smoke have long been employed against Aphides and other delicate insects, and are most useful. A quite recent advance in its use is by vaporizing. The vapor of nicotine is most effectual in destroying insects wherever it can be confined, as in greenhouses. Thus the boiling of tobacco in such a greenhouse is as effectual as and less injurious to the plants than the older methods of syringing a decoction or of fumigation by burning; while experience by Mr. William Saunders at the Department of Agriculture during the past two summers shows that the vapor gradually arising from tobacco-stems strewn on the ground and regularly moistened is likewise effectual.

White hellebore, either dry or in liquid, has long been one of the most satisfactory insecticides against Tenthredinid larvæ, otherwise known as false-caterpillars, of which the Imported Currant-worm (*Nematus ventricosus*) is a familiar type; while soap, syringed in strong suds, will kill some soft-bodied plant-destroyers, and when used as a paint on the trunks of trees is an excellent repellant against the parents of different borers.

Transcending in importance, however, any of these older insecticides are the three now most commonly used because most satisfactory.

They are: (1) arsenical compounds, (2) petroleum, and (3) pyrethrum. The first act through the stomach, and are effectual chiefly against mandibular insects; the second and third act by contact, and are, therefore, of more general application, affecting both mandibular and haustellate species.

The use of arsenic as an insecticide in the field dates from the year 1871. At the rate of 50 grains of arseniate of soda and 200 grains of dextrine dissolved in a gallon of water, and this diluted at the rate of about an ounce to ten gallons of water, it furnishes one of the cheapest of insecticides at command, and various patented combinations of it have been extensively sold and used. Again, one pound of arsenic and one pound of sal-soda boiled in one gallon of water till the arsenic is dissolved, and diluted at the rate of one quart to forty gallons of water, is also a good formula. The chief merits of arsenic are cheapness and solubility. Its demerits are its white color, which makes it liable to be mistaken for harmless substances of the same color, and its tendency to burn the plant. Paris green or Scheele's green has been more extensively used than any other arsenical compound, and is, on the whole, one of the most satisfactory insecticides. I first used this poison against the Colorado Potato-beetle (*Doryphora 10-lineata*) in the summer of 1868, but owing, doubtless, to the use of an inferior article, reported adversely upon it. (First Report on Insects of Missouri for 1868, p. 116.) George Liddle, jr., of Fairplay, Wis., experimented with it the same summer, and with one part of the green to two of flour, found it eminently satisfactory (*American Entomologist*, I, p. 219), and from the time he announced his experience—May 25, 1869—in the Galena, Ill., *Gazette*, the green became rapidly popular against the Doryphora. I first recommended it in 1872 for the Cotton-worm, and its use gradually extended to other leaf-eating insects, until hundreds of tons have been sold for insecticide purposes in a single year. It is used dry with various diluents, as ashes, plaster, flour, &c., at the rate of one part of the green (if pure) to twenty-five up to one hundred parts of the diluent. Flour as a diluent has the great advantage of causing greater adhesiveness and permanence. In liquid suspension Paris green can be used at the rate of one pound to from forty up to one hundred gallons of water. The liquid should be kept constantly stirred, and a little dextrine or other substance added to give adhesiveness is an advantage.

A refuse obtained in the manufacture of aniline dyes, and known as "London purple," is the third important arsenical compound that I will mention in this connection. It consists of lime, arsenious acid and carbonaceous matter, and was first used by me against the Cotton-worm and other insects in 1878, and more fully and thoroughly in 1879. It is used with diluents, either wet or dry, in the same manner as Paris green; while for some insects experience has shown it to be less satisfactory than Paris green, for many others it is equally effective, and has the great advantage over Paris green of being vastly cheaper (costing on an average but five cents against sixty cents per pound); of covering twice the ground, weight for weight; of being more soluble, less poisonous, more adhesive and permanent in its effects, and of decided color, so that when intelligently used it is in all ways preferable.

Petroleum, in its various forms, has long been recognized as one of the most effective insecticides in our possession, all oily substances being particularly deadly to insects. Unfortunately, they are also injurious to plants, and one of the problems the solution of which I have had in mind for many years has been their use in such dilution as to kill the insect without injury to the plant. Refined kerosene

has been used to a limited degree, by forcible attenuation in water and spray, while some plants withstand doses of the pure oil. But the safe and general use of kerosene for the purpose under consideration, dates from the year 1880. Of the various substances used in attempts to emulsify and mix kerosene with water, none are more satisfactory than soap and milk, both being everywhere accessible and cheap. Milk was first suggested in 1880, by Dr. W. S. Barnard, while carrying on experiments for me against the Cotton-worm, and subsequent experiment, especially by another of my assistants, Mr. H. G. Hubbard, has given us the simplest and most satisfactory method of making the emulsion quickly and permanently. An emulsion resembling butter can be produced in a few minutes by churning with a force pump two parts of kerosene and one part of sour milk in a pail. The liquids should be at about blood heat. This emulsion may be diluted with twelve or more parts of water to one part of emulsion, thoroughly mixed, and may be applied with the force pump, a spray nozzle, or with a strong garden syringe. The strength of the dilution must vary according to the nature of the insect to be dealt with, as well as to the nature of the plant; but, finely sprayed in twelve parts of the water to one of the emulsion, it will kill most insects without injury to the plant. An equally good emulsion may be made as follows:

Kerosene, 2 gallons; common soap, one-half pound; water, 1 gallon.

Heat the mixture of soap and water and add it boiling hot to the kerosene. Churn the mixture by means of a force pump and spray nozzle for five or ten minutes. The emulsion, if perfect, forms a cream, which thickens on cooling, and adheres without oiliness to the surface of glass. Dilute with cold water before using, to the extent which experience will indicate is best.

The simplest discoveries are often the most valuable, and this discovery of so simple and available a means of diluting, *ad libitum*, oil with water is important and far-reaching in its practical application. It were foolish to detain you with details of the several directions in which it has proved of great benefit, and which are recorded in my recent writings, especially in the reports of the entomologist of the Department of Agriculture for 1881–'82 and 1883, and in Bulletins 1 and 2 of the Entomological Division of that Department.

Pyrethrum roseum, a plant native to the Asiatic countries south of the Caucasus Mountains, and *Pyrethrum cinerariæfolium*, a native of Dalmatio, have long been known to possess insecticide properties, especially in the powder from the dried and pulverized flowers. The powder, sold under various names by druggists, was chiefly used against household pests, however, and though Mr. C. Willemot, as early as 1857, in France, and Mr. William Saunders, in 1879, in Canada, tried it in powder form on some that are injurious to plants, its importance as a field insecticide did not appear till in 1880, when, in prosecuting the work of the United States Entomological Commission, we discovered that it could be used in liquid solution. During the winter of 1880 and 1881, I succeeded in importing a large quantity of the seed of both species, and on behalf of the above named commission, distributed it to a number of correspondents in various parts of the country with a view of establishing its cultivation. Since then large quantities have been distributed from the Department of Agriculture. Both species proved to be hardy throughout the greater portion of our country, and Mr. G. N. Milco, of Stockton, Cal., has, for some years, cultivated *cinerariæfolium* quite extensively at great profit, the product being sold under the name of "Buhach." The insecticide property dwells in a volatile oil. It acts

only by contact, and its action on many larvæ is marvelous, the smallest quantity in time paralyzing and ultimately killing. Its influence in the open air is evanescent, in which respect it is far inferior to the arsenical products; but being perfectly harmless to plants it can frequently be used on vegetables where the more poisonous substances would be dangerous. Pyrethrum is supposed to have no effect on the higher animals, but that is a mistake, as my own recent experience is that the fumes in a closed room have a toxic influence, intensifying sleep and inducing stupor; while the experience of Prof. A. Graham Bell, with the powder copiously rubbed on a dog, showed that the animal was made sick and was affected in the locomotive organs very much as insects are. The wonderful influence of this powder on insects has led me to believe that it might prove useful as a disinfectant against fevers and various contagious diseases by destroying the microzoa and other micro-organisms, or germs which are believed to produce such diseases. It should be tried for that purpose. It is remarkable that these two plants of all the many known species of the genus should alone possess the insecticide property.

Of all insecticides to be used against root-feeding or hypogean insects, naphthaline, sulpho-carbonate of potassium, and bisulphide of carbon are the chief. Dr. Ernst Fischer, in a recent work, has shown that naphthaline in crystal may be satisfactorily used under ground, destroying by slow evaporation. But bisulphide of carbon still holds the first place in France against *Phylloxera vastatrix*. It is conveyed beneath the ground at the rate of one-half to one kilogram per vine by special injectors, or by more complicated machinery, drawn by horses. I believe that petroleum emulsions will supersede it as an underground insecticide, and prove to be the best we have, cheapness, safety, and efficiency considered. This glance at the chief insecticides now in use may convey some idea of the recent progress in this direction, but will convey no idea of the far greater number of substances, whether drawn from the animal, vegetal, or mineral kingdom, that have been experimented with and found wanting. After the discovery of a satisfactory insecticide, however, various important problems must be solved, and, particularly, how to apply it to greatest advantage, having safety to man and stock, harmlessness to plant, and economy, in mind. The solution of these points, and others that the peculiar habits of the insect to be controlled involve, brings us to the question of mechanical contrivances and appliances: for while much ingenuity has been exhibited in devising mechanical means of directly destroying noxious insects without insecticides, it is chiefly in the proper application of these last that the greatest mechanical advances have been made both in this country and in Europe.

Here, again, the subject is so vast that I cannot enter into details. One can form some idea of the recent activity in this direction by glancing at the figures in the First Report of the United States Entomological Commission on the Rocky Mountain Locust, my bulletin on the Cotton-worm, and other official publications. Perfection here, as in other kinds of mechanical appliances that aid man's progress in art and science, is usually the slow outgrowth of tedious trials. However brilliant the original theoretical conception, the practical details are almost always the result of sheer experiment and trial. Failures precede success. Yet success will usually follow in proportion as certain principles are kept in mind covering particular needs in special cases—principles deduced from entomological studies.

It will already have been gathered, from what has preceded, that the chief insecticides are applicable in liquid, and as liquids have an advantage over powders in field use, instruments for atomizing and distributing liquids constitute the most important part of insecticide machinery. The desiderata in a spray-nozzle are, ready regulation of the volume to be thrown; greatest atomizing power, with least tendency to clog; facility of cleansing or ready separation of its component parts; cheapness; simplicity, and adjustability to any angle.

I will content myself with exhibiting one which meets, perhaps, more of these requirements than any other in use, and which works on a new principle applicable to many other purposes than that for which it was designed. It is what has been described and illustrated in my late official reports as the eddy or cyclone nozzle, and consists of a small circular chamber with two flat sides, one of them screwed on so as to be readily removed. Its principal feature consists in the inlet through which the liquid is forced being bored tangentially through its wall, so as to cause a rapid whirling or centrifugal motion of the liquid which issues in a funnel-shaped spray through a central outlet in the adjustable cap. The breadth or height, fineness or coarseness of the spray, depends on certain details in the proportions of the parts, and especially of the central outlet. The nozzle originated at Selma, Ala., in the fall of 1880, while I was in the field, with my assistants, working at contrivances for the destruction of the Cotton-worm. In a discussion as to whether liquid forced tangentially into such a chamber would whirl or not, Dr. W. S. Barnard took the affirmative position, and experiments with a chamber improvised with two watch crystals, in which the motion of the liquid could be observed, proved the correctness of the theory. The final form of chamber adopted is the result of numberless experiments carried on by Dr. Barnard in my work, both for the United States Entomological Commission and the Department of Agriculture, and the different phases of its development may be seen by the various models which I have brought for your inspection.

Ladies and gentlemen, I thank you for your attention.

KEROSENE EMULSIONS.

It is doubtful if in the history of economic entomology in this country so great an impetus has been given to the destruction of insects injurious to vegetation as by the discovery of the simple methods of emulsifying kerosene, which we first made public in 1880, and which have been fully set forth in the reports and bulletins from this Bureau since. It is useful against many plant-feeding insects which are not affected by other insecticides, and since we announced its value against underground insects, a year ago, its use has become still more general. It is, however, against the scale-insects injurious to the Orange that it has so far proved most satisfactory. We are, therefore, pleased to state that Mr. Hubbard, special agent of the Bureau in Florida, reports that success has everywhere followed its judicious use in all parts of that State, and that the experience of another year warrants what he has heretofore said in its behalf, and that it is destined to supersede all other insecticides for use in orange groves and nurseries.

Nevertheless, former warnings against the use of mere mixtures or imperfect emulsions of coal-oil and milk or soap solutions need reitera-

tion. It cannot be too strongly impressed upon all who use kerosene as an insecticide, that it can be considered a safe remedy only when properly emulsified. The formula for the kerosene and soap emulsion, as found most satisfactory by Mr. Hubbard, is as follows:

Kerosene	2 gallons	=67 per cent.
Common soap or whale-oil soap	½ pound	=33 per cent.
Water	1 gallon	

Heat the solution of soap and add it boiling hot to the kerosene. Churn the mixture by means of a force pump and spray-nozzle for five or ten minutes. The emulsion, if perfect, forms a cream, which thickens on cooling, and should adhere without oiliness to the surface of glass. Dilute, before using, one part of the emulsion with nine parts of cold water. The above formula gives three gallons of emulsion, and makes, when diluted, thirty gallons of wash.

The kerosene and soap mixture, especially when the latter is warmed, forms upon very moderate agitation, an apparent union; but the mixture is not stable, and separates on standing or when cooled or diluted by the addition of water. A proper emulsion of kerosene is obtained only upon violent agitation. It is formed, not gradually, but suddenly; in short, to use a familiar phrase, "it comes" like butter. The time required in churning depends somewhat upon the violence of the agitation, but still more upon the temperature, which, however, need not be much above blood heat.

When obtained, an emulsion of kerosene and soap is known by the perfect union of the ingredients, and the absence of oiliness, so that the liquid clings to the surface of glass or metal. It resembles a rich cream, more or less thickened according to the proportion of soap used in the mixture.

These details have been fully set forth in previous reports, but it seems necessary to again refer to them, because, while the value of the kerosene emulsions as insecticides has been widely acknowledged, the important point of thorough emulsification has not been sufficiently recognized, and the agricultural press of the country in the discussion of this new application of an old remedy have very generally omitted to mention the methods by which a perfect emulsion may be secured.

Thus in a horticultural journal of wide distribution we find the following: "Mr. E. L. Sturtevant, director of the experimental farm at Geneva, N. Y., says that an *emulsion*, composed of one ounce of common soap, one pint of kerosene oil, and one and one-half gallons of water, *kept continually stirred while using to prevent the oil floating on the surface*, and used through the rose of a water-pot, will destroy all worms (on cabbage) that get thoroughly wet with the mixture," &c. The italics, which are our own, sufficiently indicate the unstable nature of the mixture, to which this writer wrongly gives the name emulsion.

An officer of another State institution, having become a discoverer of the means of diluting kerosene by emulsification with milk, shortly after our publication of this method, repeatedly recommended a mixture of kerosene made by stirring simply, admitting, however, that "if to be used very extensively, the permanent emulsion might be more convenient."

In Florida, where the original directions for making a good emulsion have been widely distributed, and where the remedy itself is rapidly coming into universal use among truck farmers, as well as orange and fruit growers, there is still need of greater care than is generally given to the preparation of the wash.

Failure in forming a stable emulsion is due in most cases to insufficient agitation of the mixture. The emulsion can be very quickly and easily made by using a good force pump, so constructed that it can be

inserted directly into the liquid, which must be kept in constant and violent agitation by forcing it through some form of spray-nozzle back into the same receptacle. A pump otherwise good is less adapted to forming an emulsion if, instead of being inserted directly into the pail, it has a large and long supply tube, in passing through which the liquids are comparatively quiescent and consequently have a tendency to separate.

Another frequent cause of failure is the attempt to form an emulsion by churning together a small quantity of kerosene and a large quantity of diluent. Only a very unstable union can be effected by this means. The very essence of the process requires that the oil shall be broken down by driving into union with it a smaller, or at most an equal, quantity of the emulsifying solution, after which, if a genuine emulsion is formed, it may be diluted *ad libitum* with water.

During the past year a few cases of injury to orange trees from kerosene are reported by Mr. Hubbard, in each instance arising from the use of unemulsified oil in the wash. A single case, which came under his observation, will serve as an example and give emphasis to what we have said in regard to the proper method of mixing the insecticide. He reports as follows:

"A grove of about one thousand trees, of all ages, had been twice sprayed with the standard mixture, an emulsion containing 67 per cent. of oil, diluted ten times, with beneficial results as regards infesting insects, and without injury to any of the trees. A month or two later the inside branches of about two hundred of the largest trees of bearing age were given a third application, and their main trunks thoroughly drenched with the liquid. A few weeks after the last application four of the trees appeared to have been injured, and upon examination more or less of the bark was found to have been destroyed at the collar of the tree. The dead bark still retained a strong odor of kerosene. Two of these trees died, and two are now in process of recovery.

"An investigation revealed the fact that at the last spraying the mixing of the wash had been left to negro field-hands, who had dispensed with the preliminary process of emulsifying the oil, and merely mixed the ingredients for each 30 gallons of wash, churning the whole together at one operation. The apparatus used was a large force pump affixed to a barrel and mounted on a cart. As the motion of the cart was not sufficient to keep the kerosene in suspension, it separated and floated on top of the liquid in the barrel. Thus the last trees sprayed before mixing each fresh barrel of wash received nearly pure oil, and were severely injured.

"It should be remarked that the trunks of the trees were densely shaded by low and spreading branches, which obstructed a free circulation of air and probably greatly increased the severity of the treatment by retarding the evaporation of the oil from the saturated sand and thickened bark at the base of the trees."

In California the attempt to use kerosene oil without emulsification has been attended with disastrous results to Northern fruit trees, especially when crude or unrefined petroleum was used.* This probably accounts for the prejudice which has existed against the use of coal oil in any form, and which has led the authorities in that State to recommend in preference the most heroic remedies.

* No injury to orange trees from the application of refined kerosene in any form has been reported, as far as we are aware.

The official remedy, promulgated by the State inspector of fruit pests, consists of an application of caustic soda lye, 1 pound to 1 gallon of water, or concentrated lye and water in equal parts. This, according to the official report, "temporarily burns the foliage and new wood, but the trees afterward made new growth." It is recommended for application only in winter, when deciduous fruit trees are dormant. For summer use, a mild application of whale-oil soap and sulphur, with tobacco decoction, is recommended. This "so checks the ravages of the scale as to prevent its spread to other trees during the season, and in some cases proves an entire success in the destruction of the pest." This treatment must be followed up in winter with the scorching application of lye before mentioned.*

However, a reconsideration of the respective merits of lye and kerosene washes may soon be expected on the part of Californian fruit-growers. Dr. F. S. Chapin, the chief horticultural officer, seems to have greatly modified his views, formerly hostile to the use of kerosene. In a recent report, although still advocating lye washes, we find him accrediting with the best effects a high grade of kerosene, applied with a spray atomizer. Again, he condemns as injurious a wash containing kerosene and whale oil; but finally declares: "On the whole, crude petroleum cannot be recommended; kerosene has never hurt the trees, but has destroyed the scale."

Meanwhile the lye washes appear to have had thorough trial, and with not altogether satisfactory results, as witness the following communication found in several agricultural papers of California:

"We hear of much ill-success with the common remedies for the extermination of the scale on fruit trees. While as a rule scales are yet scarce in our county, still wherever it has made its appearance the horticulturists have failed to rid themselves of the pest by the application of the official remedies, lye and whale-oil soap. * * *

"Many of the trees sprayed with strong caustics had died at the same time as the scale, and the real gain has only been in preventing the scale from further spreading."†

The following from the *Pacific Rural Press* of April 19, 1884, is a good example of recent experiments with insecticides in California:

"I first used crude petroleum, and killed about thirty peach, cherry, plum, and almond trees, or about one-half of the trees treated. Two hundred and fifty apple and pear trees were injured, but none died, and no scale appeared upon them that year. The next year I used American lye, 1 pound to two gallons of water. I killed the scale, but it came back in the fall. Last year I experimented with lye at 9°, 12°, 15°, because our chief horticultural officer recommended 1 pound of lye to 1 gallon of water. The lye burned up the buds of the Newtown Pippin apple, Bartlett and Exter Beurre pears, and I had little fruit. It burned the bark also.

"The 12° lye did some damage to the buds; 9° killed the bugs, but did not injure the buds. I treated my trees in December. The bugs appeared again the next fall.

"This year I have been using what I call improved kerosene butter, and I think it will prove a specific for the scale bug." The writer adds a formula for a mixture of kerosene, sweet milk, water, and whale oil.

Another correspondent of the same paper (*Pacific Rural Press*, January 12, 1884) writes that he tried strong lye, and also strong soap, 1

* *Pacific Rural Press*, March 15, 1884; also, *Wine and Fruit Grower*, May, 1884, vol. 6, p. 60.

†Gustav Eisen, in *Fresno Republican;* also, *San Francisco Merchant*, February 1, 1884.

pound to 1 gallon, adding sulphur, but has "more scales than ever." He wrote to parties whom he heard were successful, and learned that "no one had met with any better success." One man used 2 pounds American concentrated lye to 1 gallon. The application "killed some of the small limbs, and cracked the bark on the trunks of the largest trees, and on some of those trees where he used the strong solution he finds plenty of scale bugs yet." He had expended last year $900.

No one can doubt that such powerfully caustic applications as the above will kill scale insects if properly applied. The fact that any insect escaped an application of 2 pounds concentrated lye to 1 gallon of water shows that the aid of a good spray-nozzle is quite as important as the use of a good insecticide. In the experiments recorded above, had use been made of the "cyclone" or "eddy jet" nozzle, described in the two last annual reports from this Bureau, while the injury to the plant might not have been less, the insects at least would have been exterminated.

Our California correspondence shows also, as we foretold would be the case, that the kerosene emulsion is making headway in spite of previous prejudice.

MISCELLANEOUS INSECTS.

THE AMERICAN CIMBEX.

(*Cimbex americana* Leach.)

Order HYMENOPETRA; Family TENTHREDINIDÆ.

[Plate V, Fig. 1.]

INJURY TO WILLOWS; A NEW HABIT.

During the latter part of May last, Admiral Ammen, who is noted in Washington for his devotion to horticulture and arboriculture, brought us specimens of this large saw-fly, with an account of its injuries to his imported willows, not as usual by the larva, but by the gnawing of the perfect fly, the plantation being described as looking as if a fire had run over it, or as if it had suffered by a severe frost. As this habit was new, so far as we have any records, and as nothing was known of the mode of oviposition in the species, we had the matter investigated. The tips of many of the plants were found to be dark-brown and dead; the dried-up portion extended 2 to 4 inches from the tip. Upon investigation it was plain that the cause of the trouble was a very fine but deep transverse incision just below the dead portion of the willow, the incision often extending more than half way around the twig, or there ... number of smaller incisions, one above the other. (Pl. V, Fig. ... All these incisions were so narrow that they could hardly be supposed to have been made for feeding purposes; but in many instances a number of larger marks—usually of an oblong shape—were visible, and looked as though they had been made for food.

According to Admiral Ammen this injury was done by the saw-flies ... the latter part of May; but on the 5th of June the flies had for the most part disappeared, and Mr. Schwarz, who made examination after

our departure for Europe, found, at that date, but a single female, sitting on a branch of about 5^{mm} in diameter, and just in the act of cutting one of the incisures referred to above. The insect worked its mandibles in a very slow and deliberate manner, and made but little headway in cutting during the three or four minutes he watched its workings. Upon examination the twig was found to contain three such incisures, each reaching more than half-way around.

THE EGGS AND MODE OF OVIPOSITION.

Whether or not the cutting of the tips is made for feeding purposes, it is evident that it has nothing to do with oviposition, as no trace of the eggs could be found either on the dead part of the twig or in the living portion just beneath. The eggs are deposited between the epidermis and parenchyma of the leaf. When looking over the plants from above, the place of oviposition is hardly perceptible, appearing as a very slight, blister-like swelling, accompanied on one side by a faint ferruginous line, but otherwise not differing in color from the rest of the leaf. On the underside, however, these blisters were very plainly visible, being much paler than the rest of the leaf, and having, in the more developed condition, a reddish tinge. These blisters closely resemble those of other saw-flies, which insert their eggs in leaves and are usually nearly circular in outline (sometimes nearly oval), and distinctly elevated above the general surface of the leaf, though otherwise quite flat. They are always on the face of the leaf, usually nearer to the outer margin than to the midrib, never on or near the midrib and rarely extending across one of the side ribs. Their number varies from one to nine or more on a single leaf. Where there are several they are generally situated in a longitudinal row, the individual blisters being then always separated by the intervening side-ribs. Sometimes two rows of these blisters are found on the same leaf. The place of insertion of the ovipositor is always plainly visible, as a nearly straight slit (usually closed) of ferruginous or brownish color at or near that edge of the blister which is nearest to the margin of the leaf, thus indicating that, while ovipositing, the female fly grasps the edge of the leaf with her fore legs. (Pl. V, Fig. 1, *a*.)

Leaves infested with eggs, although not rare, were by no means so abundant as should have been expected from the extent of the injury inflicted by the imagos. A great many plants (and among them many with their tops cut off) were not infested, while occasionally a plant could be found with four or five infested leaves, mostly about the middle or near the top of the plant.

The egg, when about ready to hatch, is oblong-oval, somewhat flattened, and with its shell so thin and pliable that it not only loses its regular shape by the slighest pressure, but even by the position or movements of the embryo larva within. The shell is perfectly hyaline, with no visible sculpture besides some fine, irregular, and variable wrinkles. Its surface is very sticky. At an earlier stage the egg is elongate and nearly cylindrical. Through the whitish epidermis of the blister the shape of the egg is always readily perceptible as a transverse (*i. e.*, parallel or nearly parallel to the margin of the leaf) object of a decided green color. (Pl. V, Fig. 1, *c*.)

The young larva, after hatching, remains for some time within the blister, but finally leaves it through an irregular slit at the middle of the epidermis. Its color is bluish-gray. (Pl. V, Fig. 1, *d*.)

The recently-excluded larvæ are uniformly curled up on the under side of the leaf.

Three varieties of cultivated willows were found to be injured by the perfect saw-fly, while egg-blisters could only be found on two varieties.

REMEDIES.

It would be quite practicable, considering the small area to be protected and the conspicuous size of the insect and its clumsy movements, to catch the perfect flies by means of a net; but the application of arsenical poisons would be surer, and would also rid the willows of many other enemies.

The most numerous and most dangerous of these enemies is, beyond question, the Willow Galeruca (*Galeruca decora* Say), of which young larvæ and imagos were met with everywhere on the leaves. The character of its injury and its natural history do not appear to differ from those of the Imported Elm leaf-beetle (*G. xanthomelæna*). Its eggs are a little larger, brighter colored, and less acuminate, and the young larvæ of darker color, but not otherwise different. Full-grown larvæ were not found early in June and only a few egg-clusters. Next in number comes *Colaspis tristis*, which in the imago state preferably feeds upon the very young, not yet fully developed, leaves. Its larva, which no doubt has subterranean habits, was not met with, and it probably feeds on the roots of some other plant.

THE STREAKED COTTONWOOD LEAF-BEETLE.

(*Plagiodera scripta*, Fabr.)

Order COLEOPTERA; Family CHRYSOMELIDÆ.

[Plate VIII; Figs. 1, 2.]

On account of its rapid growth and great hardiness, as well as its beauty as a tree, the Cottonwood (*Populus monilifera*) has been extensively planted throughout the treeless portions of the West. Its insect enemies are not numerous, but two of them are extremely destructive, and, unless measures are taken to avert their injury, will soon make the growing of this tree a matter of difficulty. The first of these, the Cottonwood Borer (*Saperda calcarata* Say), we shall not treat at this time, as its injuries have not, of late, been comparable with those of the insect which forms the subject of this article.

DAMAGE DONE IN 1884.

During the past season the Streaked Cottonwood Leaf-beetle has done great damage in portions of Nebraska and Dakota. Appearing in enormous numbers, it has entirely defoliated many thousands of trees, and has destroyed many plantations of young saplings. The strip of country over which it has been particularly injurious has been along the banks of the Missouri River in Dakota, as far west as its junction with the Niobrara, and thence down through Nebraska to the Platte, as far west as Dawson County. As a sample of the many communications which have been received during the summer from the infested region,

we introduce the following, which was forwarded from the General Land Office:

YANKTON, DAK., *June* 2, 1884.

SIR: We forward to you by to-day's mail a small box containing a number of bugs gathered on yesterday on the cottonwood groves in this and adjoining counties. These bugs were first noticed during the season of 1883, when they were confined to only a few timber claims in the towns 97 and 98, ranges 57, Hutchinson County, Dakota. In the fall of 1883 they had covered quite an expanse of country, and from all sides reports came of the destruction of planted groves by these bugs. This spring nearly everybody who owns a timber-culture claim and who has called at our office reported destruction of trees, and we therefore yesterday examined into it, going through towns 95, 96, 97, ranges 55, 56, and 57, and found a condition which is really sickening. Claimants who for years and years have planted their trees, and had now succeeded in getting a good growth of trees growing, have to stand by and look on how their labor of years is destroyed in a few days. Wherever they are they are by the millions; they eat the leaves, and it only takes a few hours to finish a tree, and those trees that were attacked last year have failed to grow again this spring. So far they have attacked principally cottonwood and some box-elder. We would respectfully suggest that these bugs be handed to some expert for report and recommendation as to the best methods of destroying them. There ought also to be something done to protect claimants whose trees are now being destroyed. Most of the timber-claims in the counties named have been taken from six to ten years ago, and nearly every claimant has apparently complied with laws, at least we counted from the buggy while on a hill yesterday thirty-six different groves, presumably all timber-culture claims, where the law has been complied with, and where parties would now be entitled to make proof only for these bugs. There ought to be a special act of relief, allowing those parties to make proof, as to replant, and to commence all this work over again will be necessarily not only a hardship, but will, in a good many cases, be an impossibility, the time within which proof is required to be made being too short.

Very respectfully,

ELLERMAN & PEEMILLER.

HON. COMMISSIONER GENERAL LAND OFFICE,
Washington, D. C.

Similar letters to this were received from many points in the region indicated.

OTHER FOOD-PLANTS AND FORMER INJURIES.

This species has long been known to feed upon the leaves of the different species of Willow, but upon those trees it was never remarkably abundant or injurious. Upon several of the species of Populus it was also found, but its great liking for Cottonwood seems to be of comparatively recent acquirement. In speaking of this change of habit we remarked as follows, in the *New York Weekly Tribune* for October 9, 1878:

"The interesting feature about this insect to the forester, however, is that it has of late years acquired an especial liking for the Cottonwood. It has, indeed, become a most grievous pest in the Prairie States, where the Cottonwood is largely grown as a shade and ornamental tree, as well as for fuel. We have been surprised, in passing through Kansas and Nebraska more particularly, at the utter devastation which this beetle has produced. Vast groves have been destroyed through its incessant defoliation. Now, the Cottonwood is placed by botanists in a genus different from that of the willows, and the strangest thing about it is that the willows are not injured to the same degree, even where growing in the neighborhood of the injured Cottonwood. This is partly due, perhaps, to the fact that the Willow does not suffer so much from defoliation as does the Cottonwood, though it is possible that a special cottonwood-feeding race of the species has been of late years developed in those sections where the tree is so largely planted. This would be parallel to the well-known case of the Apple-maggot (*Trypeta pomonella*), which, though infesting wild haws and crabs in all parts of the country,

has only taken to feeding on and injuring cultivated apples in some of the New England States."

This last conclusion is rendered all the more plausible from the fact that, so far as known, the species in the Eastern States is confined to Willow and does not attack the Cottonwood.

NATURAL HISTORY.

The perfect beetles winter in sheltered localities. In the spring, as soon as the cottonwoods begin to leaf out, the beetles pair, and the females begin laying their eggs (Plate VIII, Fig. 1, *a*, *b*). These are placed upon the young leaves in dense masses of from ten to a hundred eggs. Each egg is elongate-oval, pale yellowish-white in color, rather soft, and about 0.5^{mm} long. The larvæ (Fig. 1, *c*, *d*) soon hatch and develop very rapidly. At first they are black in color and gregarious in habit, skeletonizing the leaf in the immediate vicinity of the egg-shells. With the succeeding molts the color becomes lighter and they separate, feeding upon leaves at some distance from their place of birth. These larvæ, like those of other species of the genus, are peculiar for emitting from the tips of the tuberculous spines, with which they are furnished, a milky liquid, of a pungent, but not altogether disagreeable, odor. On attaining full growth they transform to pupæ upon the leaf, fastening their hind legs to the leaf, and partially throwing off the last larval skin. The perfect beetles issue soon after. There are at least three annual generations, and probably more, as the development of the insect is very rapid. Professor Snow states* that in the month of August only fifteen days are occupied from the hatching point to the issuing of the adult.

REMEDIES.

According to all reports, but little is to be expected from the natural enemies of this species, for birds do not seem to touch it, and, with the single exception of the larvæ of lady-birds, we have neither found nor heard of any other insect enemies.

Inasmuch as it undergoes all of its transformations upon the leaves it is not susceptible to any of the trapping remedies which are used against the quite closely allied Elm-leaf beetle (*Galeruca xanthomelæna*), which was treated of in our last annual report (pp. 159–170), and the larva of which descends to the ground to enter the pupa state. In that article, however, we gave in detail the results of experiments made with the arsenical poisons, London purple and Paris green, and these results may be applied with certainty to the case of the Cottonwood Leaf-beetle under consideration. Premising with the fact that while equally efficacious in destroying the beetle, London purple seems to injure the tree less than Paris green, we repeat, for the benefit of the Western reader who may not have access to the report of 1883, the two paragraphs relating to the preparation of the poison and the effects of the mixture:

Preparation of the poison.—London purple (one-half pound), flour (3 quarts), and water (barrel, 40 gallons) were mixed, as follows: A large galvanized iron funnel of thirteen quarts capacity, and having a cross-septum of fine wire gauze such as is used for sieves, also having vertical sides, and a rim to keep it from rocking on the barrel, was used. About three quarts of cheap flour were placed in the funnel and washed through the wire gauze by water poured in. The flour in passing through is finely divided, and will diffuse in the water without appearing in lumps. The flour is a suitable medium to make the poison adhesive. The London purple is then placed upon the gauze and washed in by the remainder of the water, until the barrel is filled. In other tests, the flour was mixed dry with the poison powder, and both were afterward washed through

* *Observer of Nature*, Lawrence, Kans., November 23, 1875.

together with good results. It is thought that by mixing in this way less flour will suffice. Three-eighths of a pound of London purple to one barrel of water may be taken as a suitable percentage. Three-eighths of an ounce may be used as an equivalent in one bucketful of water. The amount of this poison was reduced to one-fourth of a pound to the barrel with good effect, but this seems to be the minimum quantity, and to be of value it must be applied in favorable weather and with unusual thoroughness. With one-half or three-fourths of a pound to the barrel, about the maximum strength allowable is attained, and this should be applied only as an extremely fine mist, without drenching the foliage.

Effects of the mixture.—The flour seems to keep the poison from taking effect on the leaf, preventing to some extent the corrosive injury which otherwise obtains when the poison is coarsely sprinkled or too strong. It also renders the poison more permanent. On the leaves, especially on the under surfaces, the London purple and flour can be seen for several weeks after it has been applied, and the insect is not only destroyed, but is prevented from reappearing, at least for a long period. By poisoning again, a few weeks later, the insect is deterred with greater certainty for the entire season. By being careful to administer the poison before the insect has worked, and, above all, to diffuse the spray finely but not in large drops, no harm worth mentioning will accrue to the plant from the proportion of poison recommended. The new growth, that developed after the first poisoning, was protected by one-fourth of a pound to the barrel in 1882. From midsummer until autumn the unpoisoned half of the grove remained denuded of foliage, while the poisoned half retained its verdure. The little damage then appearing in the protected part was mostly done before the first treatment. Eggs were laid abundantly throughout the season. Many of these seemed unhealthy and failed to develop, probably because they were poisoned. Many hatched, but the young larvæ soon died. The eggs were seldom deposited on the young leaves that were appearing after the poison was applied, but were attached to the developed leaves, and here the larvæ generally got the poison to prevent their attack upon the aftergrowth. Still the young leaves became perforated to some extent. The adults, which fly from tree to tree, appeared plentiful without much interruption throughout the season, and often several could be seen feeding on each tree. Possibly many of these may have become poisoned before depositing the eggs.

The efficiency of London purple being established, it will generally be preferred to other arsenicals, because of its cheapness, better diffusibility, visibility on the foliage, &c. As the effects of the poisons commonly do not appear decidedly for two or three days after their administration, the importance of the preventive method of poisoning in advance cannot be too strongly urged. As the effect is slow in appearing, impatient parties will be apt to repoison on the second or third day, and thus put on enough to hurt the plant when the effect does come. Much depends on dryness or wetness of the weather; but good effects may be expected by the third or fourth day.

In the same report is figured (Plate VI) a simple apparatus which was used to good effect in spraying the trees and which was explained in detail in the text (pp. 168, 169). It is in brief a barrel pump containing a stirrer-bar, attached by a loop to the swinging end of the pump, and which by its oscillations constantly stirs the mixture. The barrel rests upon a skid in the bottom of a light cart in which it is drawn from tree to tree. To the nose of the pump is attached a long, slender rubber hose. To enable the operator to thrust the hose up among the branches of the tree, it is run through a long bamboo pole the septa of which have been burned out by a hot iron rod. At the end of the hose is a short metallic rod to which one of the cyclone or eddy-chambered nozzles has been attached.

By the use of such an apparatus, which is comparatively inexpensive, a great many trees can be thoroughly sprayed in the course of a day. Such a course requires labor and some expense, but the result can be accomplished in no easier way.

DESCRIPTIVE.

We have already given the general appearance of the egg, and the larva will be readily recognized from the figures (Plate VIII, Figs. 1, *d*, *d*, *f*). It is practically indistinguishable from the larva of the closely allied *Plagiodera lapponica* which feeds upon Willow at the North, but the larva of the latter species emits the milky fluid more freely and has

perhaps a more pungent odor. We published in the *American Entomologist*, Vol. III, p. 160 (July, 1880), a detailed description of the larva, which it will be unnecessary to repeat here.

The beetle is extremely variable in its coloration, and it may not be amiss it this place to repeat in connection with Plate VIII, Fig. 2, *a*, *b*, *c*, *d*, *e*, for purposes of identification, the description which we have given (*ibid.*) of certain of the more marked varieties. Combinations, however, in many degrees, of these varieties occur.

a. *Typical.* Black, with a tinge of blue; basal joints of antennæ beneath, thickened thoracic margin with exception of a small round spot at the middle, elytra with exception of suture and three lines of interrupted black markings, base of femora and part of tibiæ, and sides and apex of abdomen, testaceous yellow. (Common West.)

b. *Variations in general Coloration:*

1. Base of antennæ, head, underside, and legs of the same yellowish color as upper side. (From Texas.)
   - *α.* Thorax testaceous-yellow, or more reddish, with the two lateral markings and a Y-shaped mark on the disk blackish.
   - *β.* Thorax entirely testaceous-yellow.
2. Principal color above and beneath blue; legs blue.
   - *γ.* Sides of thorax as in typical form. Elytra with faint yellow marking. (From California.)
   - *δ.* Sides of thorax as in typical form. Elytra unicolorous blue. (From California.)
   - *ε.* Entirely blue, except a narrow lateral yellowish marking each side on the last abnominal joint.

c. *Variations in the Markings of the Elytra:*

1. Marked with black as follows: the suture; two, more or less, oval spots near the base, the inner of which is nearer to the suture than to the lateral margin, and the outer on the humerus; three longitudinal striæ on the middle, the intermediate of which is the longest; submarginal curved stria and an oval spot between the latter and the suture. (Common West.)
2. Additional marks: A small triangular basal spot in front and between the two subbasal markings. (Illinois.)
   - *α.* This triangular spot is sometimes connected with the humeral spot. (California.)
   - *β.* Black markings become wider or longer and then often confluent.
   - *γ.* Markings in general becoming smaller, either all of them, or one or several of them.

THE SOUTHERN BUFFALO GNAT.

(*Simulium* sp.)*

Order DIPTERA; Family SIMULIDÆ.

[Plate IX, Figs. 1, 2, 3.]

LOSSES IN FORMER YEARS.

For many years past one of the greatest pests the stock-raiser of the South and West has had to contend with has been the so-called "Buffalo Gnat." This insect is a small fly, closely related to the well-known "Black Fly" of the Northwestern woods. At certain seasons it swarms in immense numbers, and by its poisonous bite, multiplied a thousand-fold, causes great destruction amongst sheep, hogs, poultry, cattle, horses, and mules. In 1872 it was reported that the loss of horses in Crittenden County, Arkansas, from this source, exceeded the loss from

*The species concerned in the damage in the Southwest, and which goes by the name of "The Buffalo Gnat," has not, so far as we are aware, been specifically determined. The only specimens we have seen were received from Mr. M. H. Thompson, of Pecan Point, Ark., and these were so mutilated that identification was impossible. The genus is also a difficult one on account of the insufficient descriptions extant and a great general resemblance of the species.

all diseases.* In 1874 the loss occasioned by the gnat in one county in Southwest Tennessee was estimated at $500,000.†

DAMAGE DONE BY EUROPEAN SPECIES.

Closely-related species occur in Europe; one in particular has been extremely numerous for over two hundred years, in Hungary, particularly in the vicinity of the town of Kolumbacz. Schoenbauer published in 1795 a work on this insect.* From his account it appears that the pest did not appear every year in the same degree, and that rainy weather and strong winds diminished their numbers. The flies appear first between April 20 and 30, and are most numerous at the beginning of May. They seek shelter from the rain and wind in the caves near the valley, and cover the walls of the caves, as well as the interior of hollow trees and the cracks of stone fences, to the thickness of a finger. In 1783, on the tract of land belonging to the imperial mining institution, the following animals were killed by them: 20 horses, 32 foals, 60 cows and oxen, 71 calves, 130 hogs, and 310 sheep. Schoenbauer witnessed the *post-mortem* of a horse killed by the gnats, and upon dissection it was found that not only was the anus entirely filled with the flies, but also the genital orifices, the nasal passages, and the bronchial tube and its ramifications. As to remedies, he states that it is customary to drive them away by smoke. A salve which he recommends very highly for anointing the cattle is prepared as follows: Take 2 pounds of tobacco leaves and boil in 20 pounds of water until half is boiled away. This decoction, poured from the leaves, is then boiled in a broad vessel until of the consistency of honey. To this is added 1 pound old lard and half an ounce of kerosene. With this the cattle should be smeared every third day on their tender parts, and particularly nose, mouth, ears, &c.

From the time of Schönbauer to the present day the same species has made its appearance, from year to year, in varying force, in that region; but four years since the following dispatch was forwarded to us by the Department of State, and will indicate the amount of damage still being done:

LEGATION OF THE UNITED STATES,
Vienna, July 27, 1880.

SIR: Some months ago a certain venomous fly, which has appeared at intervals, issued in one or two swarms from a certain mountain in Hungary, called Columbatz, and descended into the agricultural districts. It is called the *fly of Columbatz*, as it is not elsewhere found. Its haunt there is reported to be a hole or cave in the mountain, where it preserves and propagates its species. From this habitation it issues, under some impulse or instinct unknown, to attack living animals, and moves in a furious swarm like the ancient migrating tribes of destructive warriors, who issued from the dark forests of old Germany in the time of Cæsar. Yet their physical structure is so delicate that a strong rainfall destroys them in myriads when exposed to its force.

In the spring of this year they were very destructive. A conception of the losses they inflict may be formed from the official report made from one single county into which they descended—the county of Hunyad. There were destroyed by them in this county, this year, 158 buffaloes, 186 oxen, 175 cows, 56 calves, 49 sheep, 118 horses, and 1,137 hogs. In one instance they attacked a man whose neck was exposed, and whose life was in danger at the time the report was written.

I am, sir, your most obedient servant,

JOHN A. KASSON.

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*Ann. Rept. Commissioner of Agriculture, 1872, p. 32.

† *Field and Forest*, v. I, p. 2 (June, 1875).

‡ *Schoenbauer, J. A.*—Geschichte der schädlichen Kolumbatczer Mükken im Bannat. Wien, Patzkowsky, 1795. An abstract of this work, by Snellen van Vollenhoven, entitled "Jets over de Colombatscher Mug," was published in Jaarb. kgl. zool. Genootsch., Amsterdam, 1860, pp. 129–135, and was translated into German by Dr. C. A. Dohrn, Stettiner entomolog. Zeitung, 1860, v. 21, pp. 306–319.

But little progress in the study of this species seems to have been made in the last hundred years. Besides the Hungarian insect and that found in the Southwestern United States, we may mention that a species of this genus is very abundant in Lapland; another does much damage in Brazil. The "black fly" of the north woods we have already mentioned; and, lastly, Mik has recently given an account of *Simulium vexans*, an insect of similar habits found in Australia.

EARLY STAGES OF EUROPEAN SPECIES.

Schönbauer first discovered that the early stages of the Columbacz midge—egg, larva, and pupa—were passed in the water, and only left that element to transform to the perfect insect. Some time afterwards Verdat* and Fries† published the transformations of *Simulium sericeum*. The larvæ of this species live under the surface of the water, on the stems of water-plants of the genera *Phellandrium* and *Sium*.‡ The larvæ are slender, cylindrical, and furnished near the mouth with two singular flabelliform appendages. The pupæ have, on each side of the front of the thorax, eight long filiform appendages arising in pairs. The posterior part of the body is inclosed in a semi-oval cocoon attached to the plants. The fly issues below the surface of the water, and rises to the top protected by a fine silky covering of hairs.

EARLY STAGES OF AMERICAN SPECIES.

The early stages of several of the American species have been studied. In the *American Entomologist* (Vol. II, p. 227, June, 1870), under the heading "The Death-web of Young Trout," we described the larva and pupa, with figures, of a species afterwards described by us as *Simulium piscicidium* (*ibid.*, p. 367). These larvæ were said by Seth Green to live attached to stones in swift-running water and to spin a silken thread in which young fish became entangled and killed. This statement created much excitement among fish-culturists at the time, and really seemed very plausible. It was contradicted, however, by Sara J. McBride, of Mumford, N. Y., in an article published in the same volume, pp. 365–367 (December, 1870), and also by Fred. Mather, of Honeoye Falls, N. Y., in private correspondence with us. Mrs. McBride found that the perfect flies issued about the 1st of April, and the 1st of June thereafter the larvæ were found in the streams in great numbers—as a general rule attached to water-plants 3 or 4 inches below the surface of the water. Some were also attached to stones at the bottom. The majority were fastened to green, decaying water-cress, and these were green in color, while others which held to dead forest leaves of the previous year's growth, which had become entangled with the cress, were brown. From this fact she justly argued that they fed on decaying vegetation. There was a succession of broods throughout the season, the development of a single brood occupying about two months. The flies issuing in midsummer were smaller than those developed in the spring and fall, although no difference in the size of larvæ and pupæ was perceptible.

In the same volume (pp. 229–231) Osten-Sacken gives an account of an undetermined species found attached to rocks and plants in swift-

* *Verdat, G.-J.*—Mémoire pour servir à l'histoire des Simulées, genre d'insectes de l'ordre des Diptères, etc. Naturwiss. Anzeig. d. allg. schweiz. Gesellsch., 1822, v. 5, No. 9, pp. 65–70.

† *Fries, B. F.*—Observationes entomologicæ. Resp. Liljevalk, Pars I. (Simulia.) Stockholm, 1824. 8°. Reprint, Thon's Archiv, 1830, v. II, 2, p. 69–73.

‡ Several species of Sium are found in this country, and are known as "Water parsnips."

running streams in the vicinity of Washington. This article contains also an able review of previous writings on the subject, and is illustrated with figures taken from Verdat.

In the *American Entomologist* (Vol. III, pp. 191–193, August, 1880) Dr. W. S. Barnard described the stages, with figures of the eggs, of a species common in the mountain streams around Ithaca, N. Y. The eggs were found on the rocks on the banks a few inches above the surface of the water; the newly-hatched larvæ were just at the surface, and from this point there was a regular gradation in the size of the larvæ down into the stream. The eggs were found abundantly on the 1st of June.

In the Proceedings of the Boston Society of Natural History for January, 1880, Dr. Hagen described *Simulium pictipes*, a remarkably large species, the larvæ and pupæ of which were found in the rapids of the Au Sable River, Adirondack Mountains, and in mentioning the fact in the *American Naturalist* for April, 1881, we stated that the larvæ and pupæ of presumably the same species were found by Messrs. Hubbard and Schwarz in the rapids of the Michipicoten River, north shore of Lake Superior. The larvæ were there found to have the peculiarity of floating in long strings, attached to each other by silken threads, while the pupæ, found in the quieter pools close by, resembled clusters of coral.*

The history of the early stages of the "Buffalo Gnat" of the Southwest has never been made out, but a good idea of the probable appearance of the larvæ and pupæ and of their probable habits will have been gained from what precedes, and from the figures (Pl. IX, Figs. 1, 2, 3), and we hope soon to hear from observers in the South and West that the life-history of the species is thoroughly understood.

RECENT RAVAGES.

The "Buffalo Gnat" has been especially injurious since the Mississippi floods of 1881 and 1882. In 1882 the papers contained many notices of the damage similar to the following, which we clip from the *American Grange Bulletin* of June 22, 1882:

"The Buffalo Gnat has appeared this spring in immense numbers in Eastern Kansas, Western Tennessee, and Western Mississippi, and the great destruction of cattle, horses, and mules caused by it has added to the distress of the inhabitants of those sections of the country caused by the unprecedented floods."

Some localities along the Mississippi River, in Arkansas, also suffered severely in 1882, as the following communication from Mr. M. H. Thompson, of Pecan Point, Ark., under date of March 21, 1882, will show:

This day I send you by mail a specimen of gnat called the "Buffalo Gnat." They come with the first spring days. This season they are here in countless millions, more than were ever known. They kill work-stock in a few hours; many have already died from the effects of their bite. We lost in one day last week three mules. Generally they can be kept off by applying fish oil on the horse. This season it is of no avail, and the only remedy is to put the horse in the stable, when they at once leave him, supposed to be from the smell of ammonia in the stables. No planter here on the river bottoms can plant now on account of them. They are supposed to remain until hot weather, which drives them away. * * * Horses bitten by them swell and act

* We also hazarded the statement that these were the immature forms of the celebrated "black fly" of the Lake Superior region; but Dr Hagen, in comparison of specimens of these larvæ and pupæ received from Mr. Hubbard, with similar stages of *S. pictipes*, remarked (*Canadian Entomologist*, Vol. XIII, pp. 150, 151) that while the larvæ and pupæ did not differ materially, imagines from Lake Superior (not raised from pupæ collected by Mr. Hubbard) differed from *S. pictipes* in their much smaller size and in the color of the legs.

very much as though suffering from colic, and die in a few hours. Whisky is said to be an antidote. * * * When they first appear they are much larger than when they have remained a few weeks, and when they first appear are more deadly to the stock. * * * They are worst during seasons like the present—a big overflow of the Mississippi River.

During the present year (1884) the ravages of these gnats in portions of Louisiana and Mississippi seem to have been worse than ever before. The following is a sample of several communications which we have received on the subject:

MONROE, LA., *April* 16, 1884.

DEAR SIR: I beg leave to address you on the subject of the greatest pest that has ever afflicted this country—the Buffalo Gnats. I do not think the Department of Agriculture at Washington or the public at large fully appreciate the fearful destructiveness of this plague. The loss and suffering caused by it every year are terrible. To my mind these abominable gnats cause more injury than the grasshoppers, cabbage-worms, cotton-worms, phylloxera, and other insects to which you have devoted so much profound and useful investigation. These latter affect vegetation, while the gnats destroy animal life, and, unless checked by some better preventive or remedy than any known or used at present, they will render farming or even living impossible in a large and fertile section of the United States. They get larger, more numerous, and more ravenous every year. Hogs, poultry, and cattle die in great numbers, and what survive are reduced and poisoned so that they are a long time recovering from the affliction. The mules and horses die spite of all precautions. This year these gnats have for the first time been as bad at night as in the day-time. They fill the entire atmosphere like an immense swarm of bees, seeming to burst forth from the whole surface of the earth. The flies that plagued Egypt could not have been worse. The worry and pain of the poor brutes is horrible, and humanity demands that some relief should be invented.

We use smokes and oils of various kinds, but these remedies are inadequate, not only for work-stock, but for cattle which run at large.

The gnats are not entirely due to overflow, for they infest portions of the country where there is no overflow, and I am satisfied in a few years they will spread over the whole South and West.

Is there not something which could be fed to stock that would make their blood poisonous to the gnats? Or could the parents which breed these pests be destroyed by any means?

Hoping that you may thoroughly investigate this subject, I remain,

Very respectfully,

A. A. GUNBY.

Prof. C. V. RILEY,
United States Entomologist.

REMEDIES.

Smudges.—The good effects of a smudge, or thick smoke, in keeping off the gnats have long been known. This method is in use at the South at the present time, and also in Hungary. The customary method in Hungary is simply described by Kollar as follows:

"For this purpose they (the inhabitants) collect large and longish heaps of straw, hay, foliage, dry dung, &c., both near their houses and also in the pastures. A brand is put in the middle and the heap begins to burn slowly and causes thick smoke, which prevents the approach of the gnats. The cattle there, which know the effect of the smoke, fly eagerly to the smoke-heap as soon as they perceive a cloud of gnats, or, when these gnats annoy them greatly, lay themselves down by the heap, and always on that side of it to which the smoke will be driven by the wind or current of air."

It will be unnecessary to elaborate upon this subject, as it is a remedy which is well understood wherever these insects abound.

Body applications.—We have already given, under the caption "Damage done by European species," the salve recommended by Schönbauer for the purpose of anointing the animals to keep away the gnats. This, however, is tedious in its preparation, and, from its consistency, difficult to apply with rapidity. The use of oil of tar, by the

employés of Hudson's Bay Company, against the "black fly" of the Northern woods, and the fact that long experience has shown it to be preferable to pennyroyal or any of the common prophylactics, suggests a simple and easily applied wash which we have for several years recommended to our correspondents. A quantity of coal-tar is placed in the bottom of a large shallow receptacle of some sort, and a small quantity of oil of tar, or oil of turpentine, or any similar material, is stirred in. The receptacle is then filled with water, which is left standing for several days until well impregnated with the odor. The animals are then washed with this water as often as seems to be necessary. A number of other washes have been recommended and are in use, but this seems to be the most satisfactory.

Suggestions.—These smudges and washes are simply preventive in their character, and by their use the numbers of the insects are not lessened in the slightest degree. This article can only be considered as introductory to a more extended investigation either by this Bureau or by the persons directly interested. It places before the latter all the known facts concerning the life-history of allied species, and is intended to indicate lines of investigation which should be followed up.

With the descriptions and figures already given it ought not to be difficult to find the larvæ and pupæ of the Southern Buffalo Gnat and its breeding places. It seems unlikely to us that it breeds in the Mississippi River itself, but rather in the smaller tributary streams, in the shallowest and swiftest water. Such breeding-places once ascertained, it ought not to be difficult to kill the insect in its earlier stages on a large scale by the introduction of some poisonous substance, even at the expense of the food-fishes. If it should be found, on the other hand, as is not impossible, that the larvæ live attached to the stems of the water plants in the Mississippi itself, attempts to prevent the multiplication of the species will have to be abandoned as impracticable.

It seems to be a fact, from the evidence of European writers, that the Columbatz fly swarms during bad weather in the mountain caves, in hollow trees, and in other similar sheltered places. Such swarming places should be searched for with a view of destroying the insects *en masse* when found.

Experiments should also be made with a view of trapping the gnats, if it can be ascertained that they are attracted by fires or by any food substance.

These suggestions are simply thrown out as possibilities, which future study will have to prove or disprove.

THE ANGOUMOIS GRAIN-MOTH.

(*Gelechia cerealella*, Oliv.)

Order LEPIDOPTERA; Family TINEIDÆ.

[Plate VI, Figs. 2, 3.]

PAST HISTORY AND DISTRIBUTION.

A very important insect at the South to-day is the so-called Angoumois Grain-Moth. It abounds in the Southern corn-fields and granaries to an alarming extent; but as we go North its numbers lessen and its injuries decrease. It is difficult to give its native home with certainty, but the probabilities are that it was originally a South European insect.

It has been known in this country since 1728, and was probably introduced by the early settlers of Virginia and the Carolinas. No insect is more easily carried from one country to another, as it will breed for years without intermission in a bottle of grain kept as a sample, or will remain unsuspected in kernels in parcels of seed.

Its popular name—"Angoumois Moth"—is derived from the fact that it has long been very destructive in the province of Angoumois, France, where it is said by Dr. Herpin to have made its first appearance about 1750. Duhamel, in 1762, seems first to have made use of the term "l'insecte de l'Angoumois," and the title of his paper is "Histoire d'un Insecte qui dévore les Grains de l'Angoumois." From that date to the present time this pest has attracted much attention in France.

Curtis, in 1860 (*Farm Insects*, p. 310), stated that it had not yet appeared in England, but it must have appeared there soon afterwards, as in the British Museum Catalogue of Lepidoptera, Part XXIX (1864), it is entered as from England. It is also found in North Africa, and apparently occurs all along both sides of the Mediterranean.

In a paper by Col. Laudon Carter (Transactions American Philosophical Society, 1768), it is stated that the injury to wheat began in North Carolina in 1728, and in the next forty years had extended from North Carolina into Virginia, Maryland, and the lower counties of Delaware. Later, it spread still more extensively, and Harris (Insects Injurious to Vegetation, 2d ed., 1852, p. 503) states: "This fly-weevil, or little grain-moth, has spread from North Carolina and Virginia, where its depredations were first observed, into Kentucky and the southern parts of Ohio and Indiana, and probably more or less throughout the wheat region of the adjacent States between the thirty-sixth and fortieth degrees of north latitude. But these are not the extreme limits of its occasional depredations, as it has been found even in New England, where, however, its propagation seems to have been limited by the length and severity of the winter."

Glover, in the Patent Office Report for 1854, states that he had previously observed the moths in Georgia flying about the corn-fields in November, and literally swarming about an old shed in the middle of the field. They are at the present day to be found all through the South, and that they occur (at least occasionally) as far north as 43° north latitude is shown by the fact that Dr. Fitch found them in the museum at Albany, and that they were recently found in corn sent from Lansing, Mich., to Connecticut, and afterwards forwarded to us.

NATURAL HISTORY AND METHOD OF WORK.

The old statement concerning the eggs is: "The female moth lays a cluster of from twenty to thirty eggs upon a single grain, in lines or little oblong masses in the longitudinal channel." Our own observations and experiments on the moth in confinement show that the eggs are preferably laid (in ears of corn) under the thin membrane which adheres to the basal portion of the seed, and although the membrane adheres very closely the moth manages to insert her ovipositor under it. They are also deposited in both the longitudinal and transverse grooves between the grains. Sometimes there is only a single egg, though usually they occur in batches of as many as twenty-five. The eggs are delicate, flat, and oval, and are pale red in color, with prismatic reflections (Plate VI, Fig. 2, *e*).

The young larvæ are very active and crawl rapidly about, suspending themselves by silken threads. They soon find tender places and

bore into the kernels, leaving almost imperceptible openings. With wheat it is stated that a single grain has never more than one occupant, but with corn two or more are usually to be found. The larva is smooth and white, with a brownish head and prothoracic plate (Plate VI, Fig. 2, *a*). With the smaller grains it has been inferred, from the fact that the quantity of excrement in the grain seems less with the full-grown larvæ than with the younger ones, that the larvæ eat their own excrement once or twice. At full growth the larva cuts a circular hole in the cortex of the seed for the exit of the future moth, without, however, displacing the stopper thus formed. It then spins a delicate cocoon within the grain, in which it transforms to pupa (Plate VI, Fig. 2, *b*). The moth (Plate VI, Fig. 2, *c*) issues through the previously prepared hole and is of a very light grayish-brown color, more or less spotted with black, and with an expanse of wing of about half an inch (12.5^{mm}). Ears of corn frequently have every kernel affected by one or more larvæ, and present the appearance of our figure (Plate VI, Fig. 3) after the moths have issued.

NUMBER OF ANNUAL GENERATIONS.

In Europe there are two broods a year, the moths issuing in May and June and again in November, with occasionally an intervening brood. We may repeat the oft-quoted statement of Olivier: "One thing worthy of remark is that the moths which hatch in the month of May from the grain shut up in the granaries, hasten to get out by the windows and to gain the fields, instead of which those that come forth immediately after the harvest make no attempt to escape. It seems that their instinct informs them that they will then find no more provision in the fields for the support of their posterity." In this country the number of broods seems to be the same (two) in the more northern States, as observed by Harris in Massachusetts. Farther south, however, Mr. Ruffin found that all the stages were passed through from September 2 to October 6, and he inferred that in the climate of Lower Virginia there are at least five successive generations from June to October. He also concludes that while there is a continued reproduction of the insect at short intervals in stored grain, comparatively few eggs are deposited on corn in the field; but this is a point which must vary to a considerable extent with the climate, and we know that the farther south we go the more corn is infested in the field.

RESULTS OF ITS WORK.

Aside from the great loss in weight which grain suffers from the attacks of this insect, its germinative power is lost and the qualities necessary for nourishing food are taken away. We translate from Dr. Herpin: "The bread made from wheat attacked by the *Alucita*, and especially when the flour has not been suitably bolted, contains the *débris* of the bodies and excrement of the insect. It has a disagreeable and loathsome taste, which is very lasting. It lacks adhesiveness and breaks up in water like a lump of dirt. It is even said that a very dangerous throat disease results from the use of this unhealthy food—a disease which has been epidemic for some years in regions infested by the *Alucita*. It manifests itself by gangrenous ulcerations which form in the back of the mouth; the sick succumb in a few hours and cannot be aided."

PARASITES.

"Réaumur mentions a parasitic fly which sometimes hatches from grains containing the caterpillars, or pupæ, to the number of twenty from one insect." (Curtis.)

"Mr. Owen has made the interesting discovery, that the larvæ of the wheat-moth are sometimes preyed upon by still smaller larvæ, which, having destroyed their victims, are transferred to minute black ichneumon-flies. These have not yet been obtained from any of the samples of the infected wheat or corn that have come under my notice; but, from the figures given of them by Mr. Owen in *The Cultivator*, for November, 1846, they appear evidently to be Chalcidian parasites, and belong perhaps to the genus *Pteromalus*. Of these parasitical flies he remarks, that 'some farmers had noticed large numbers among the tailings of the winnowing machine.' Where they prevail, they doubtless contribute, in no small measure, to check the increase of the moths." (Harris.)

Recently Mr. F. M. Webster, of Normal, Ill., forwarded to Mr. Howard for determination specimens of a *Pteromalus* which he had bred from the larvæ of the Angoumois Moth. This species, in all probability, is different from the parasite bred by Réaumur, but may very possibly be identical with the insect figured by Mr. Owen. It cannot well be characterized except in connection with a careful study of the genus, which neither we nor Mr. Howard have yet had time to make.

REMEDIES.

The problem of a complete, satisfactory, and, at the same time, inexpensive remedy for this insect, is rather a difficult one to solve. So long as the Southern planter must leave his corn standing in the field all through the fall and main part of the winter, while the more important work of cotton picking and ginning is going on, he must expect that when it is finally harvested both the Angoumois Moth and the grain-weevils (*Calandra remotepunctata* and *C. oryzæ*) will already have gained an entrance to the ears. It remains, then, to kill the insects in the grain when housed or just before storing it away, thus putting a stop to further damage by these individuals and lessening by so much the numbers of the succeeding broods. With this view many experiments have been made in France, and costly machines have been constructed to accomplish the desired end. The machine of M. Marcellin, Cadet de Vaux, consists of a large iron cylinder similar to a coffee-roaster; the grain placed within and kept revolving at a uniform temperature of 60° R. [167° F.] for fifty minutes, when it is withdrawn. All larvæ, pupæ, and eggs are thus killed; the grain undergoes no fermentation, and its germinative power is uninjured. Dr. Herpin, finding that a violent shaking or concussion of the grain will also destroy the eggs and even the contained larvæ, invented an agitator or shaking machine (*tarare*) furnished with wooden or iron wings, propelled at a velocity of 600 times a minute. For the invention of this machine, the cost of which was 500 francs ($100), Dr. Herpin received the gold medal of the Société Impériale et Centrale d'Agriculture, and also the first-class medal of the Universal Exposition of 1855.

A much simpler and less expensive plan than this will, however, be found in the adoption of a sort of quarantine station in the shape of a large and tight bin in which corn or wheat could be temporarily placed while the insects are destroyed by some one of several agents. In case

this also should be thought too expensive, some simple contrivance can easily be arranged by means of which the ordinary crib can be rendered temporarily tight enough for the purpose. A cloth covering, painted or varnished, so as to render it water-proof and as tight as possible, could be cheaply made so as to cover the entire crib from the top of the roof to the ground. After every crack has been closed as tightly as possible, an open vessel containing bisulphide of carbon should be placed on the corn. This substance is extremely volatile, and at the same time in the form of a vapor it is heavier than air and would rapidly permeate the mass of grain. The greatest of care must be taken with the bisulphide, as it is extremely inflammable, and no exposed flame should be brought into its vicinity. In the summer of 1876, at the Department, we had experiments made with this substance on this and other grain weevils, employing for the purpose a large zinc box. The experiments were satisfactory on this small scale, and the idea of using it on a larger scale was first suggested by us later in the *Farmers' Review* for March, 1879, in an article on the Rice weevil.

Mr. Edward Ruffin's remarks on the simpler prophylactic plans are so sensible that we quote them in full:

"1. Corn may be kept for years *nearly* exempt from the attacks of the weevil by being housed in the shuck, or husk. I have known it to be thus kept through the third year, and much more free from injury than shucked corn is in August, and even the July succeeding the gathering. But this mode requires much more house-room and much additional labor, if adopted for the whole crop or for that portion designed for sale; still, all required for bread at home, after the beginning of summer, may be well and ought to be kept in the shuck. The reason of exemption from the weevil is obvious. The few larvæ which may be in the corn when housed in autumn, perish because they are not able to escape from the compact bulk; and the same compactness prevents the access of laying-moths approaching from other places. The grains exposed by the opening of the shuck, and those only of ears at the outside of the bulk, are all that can be reached or suffer from the weevils at all.

"2. If, instead of keeping the corn in the ear and shucked, as usual, until wanted for food or market, it were shelled in May, or before the coming out of the first summer broods of weevils, and kept in bins or in bulk, there would be very little damage from all the succeeding generations. The first few moths would perish by confinement, except those produced in grains then on the surface of the bulk; and none others could deposit otherwise than on the surface of the grains. It is obvious that every change of the surface exposes to such injury a new layer of grain before untouched, and, if left undisturbed, the surface grains will serve to shield all below them. When the corn is about to be sold, the weevil-eaten surface of the bulk may mostly be separated by strong fanning or a previous raking off of all the surface corn, which may be reserved for stock-feeding.

"3. Wheat, as soon as reaped, and perhaps sooner, is supplied from the granaries with a greater or less number of parent weevils to lay the earliest brood, and if it remains in the straw until September, and when threshed is left in small bulk, or often stirred, nearly all the grains may be weevil-eaten; but if wheat be threshed and well fanned early in July, in this region, there will be no weevils worthy of notice. The eggs previously laid probably do not exist on the grains, but on the chaff or shuck in which they are inclosed, and, in hatching, the maggots must perish for want of food. As in the case with corn, the bulk of clean

wheat is not exposed to subsequent layings, except on the grains at the surface of the bulk. Even if the eggs had previously been attached to and had remained with the grains instead of the chaff, as I infer to be the case, and then hatched in the interior of the bulk, the weevils could not escape from such close confinement, but would die without increase.

"Seed wheat is usually kept spread out at least 10 inches thick, in order to avoid any possible heating from remaining moisture, and by some farmers is frequently stirred, both of which conditions offer a greater opportunity for the depredations of these insects. Notwithstanding this, it is rare that they become numerous.

"4. The bulking of early-threshed wheat without separating the chaff is also said to be sufficient protection from the weevil. Of this mode I have no experience. Its efficacy must depend, not on the removal of the eggs, but on the stifling of the maggots and the inability of either the maggots or the moths to move in so close a mass."

DESCRIPTIVE.

Inasmuch as no good description of the egg has yet been published, we append here a short description of eggs laid by moths in confinement, February, 1882. Dr. Fitch's descriptions of the other stages are very full and accurate:

GELECHIA CEREALELLA—*Egg:* Shape a flattened oval, broadest at the middle, rounded at the apex, flattened somewhat at base; length 0.6^{mm}, greatest breadth 0.2^{mm}. Surface wrinkled, with eight or nine delicate longitudinal carinæ, which are almost entirely obliterated in the middle, and with numerous still more delicate transverse ridges. Color pale red, with prismatic reflections.

THE COTTONY MAPLE SCALE.

(*Pulvinaria innumerabilis*, Rathvon.)

Order HEMIPTERA; Family COCCIDÆ.

[Plate X; Figs. 1, 2, 3, 4.]

DISTRIBUTION.

This scale insect stands prominent among the species which have been especially abundant during the past summer. Circumstances appear to have been particularly favorable to its development, and, although it does not spread rapidly, its general appearance this season has caused considerable alarm in many States. It was sent to us during the spring and summer by correspondents in New York, Pennsylvania, Maryland, Virginia, Ohio, Indiana, Michigan, Illinois, and Missouri. For the past thirty years it has attracted considerable attention as damaging shade trees, particularly the maples, in different parts of the country, occurring in extraordinary abundance from time to time, and then almost lost sight of for several years. It is more particularly a Northern insect, and although it is often numerous in Virginia and Missouri, we have never received it from, nor heard of its occurrence in the extreme Southern States.

HISTORY AND SYNONYMY.

The species was originally described by Mr. S. S. Rathvon in the *Pennsylvania Farm Journal* (Vol. IV, pp. 256–258, August, 1854) as

Coccus innumerabilis, and five years later by Dr. Asa Fitch as *Lecanium acericorticis* (Trans. N. Y. State Agr. Soc., 1859, pp. 775, 776). Both of these descriptions were lost sight of for a number of years, and the species was redescribed, editorially, in 1869, in the *American Entomologist* (Vol. I, p. 14) as *Lecanium acericola*. In the meanwhile, Dr. Joseph Leidy had written an article upon the same insect in 1862 (Report to the Councils of Philadelphia on some of the insects injurious to shade trees, pp. 7–8, 1862), in which he identified it as the *Coccus aceris* of Europe. Some time (February 7, 1871) after the publication of our description of *Lecanium acericola* we received letters from Mr. Rathvon, calling attention to his figure and description of *Coccus innumerabilis*, and suggesting the identity of the two. Subsequent correspondence, and a copy of the original paper, convinced us of the correctness of the surmise, and we communicated this conclusion, in 1879, to Mr. J. D. Putnam, who consequently published his lengthy and admirable account of the species (Proc. Davenport Acad. Nat. Sci., Vol. II, Part II, pp. 293–347, December, 1879) under the old name *innumerabilis*, placing it, as we had suggested in our correspondence with him, in the genus *Pulvinaria*. Glover (Ann. Rept. Dept. Agr., 1876, p. 44) in 1877 revived Fitch's name of *Lecanium acericorticis*, which had been overlooked up to this time. Mr. Putnam's (1879) paper, to which we have just referred, is by far the most complete and accurate article which has been published on the species, and from it we have drawn many of the facts given in our paragraph on the natural history of the insect. In the course of the preparation of his paper we communicated to Mr. Putnam all of our own notes in regard to the species, and especially those in reference to the synonymy and food-plants, which he has embodied. Walsh, in 1869, bred the male abundantly, and in 1875 we ascertained from specimens received from Suel Foster, of Muscatine, Iowa, the fact that the male is found on the leaves. In addition to the papers already mentioned, Miss E. A. Smith published a lengthy illustrated article in Thomas's Second Report as State Entomologist of Illinois (published in 1878) under the name *Lecanium acericola*. Soon after she published substantially the same article in the *American Naturalist* (Vol. XII, pp. 655–661, October, 1878), using this time Fitch's name, *Lecanium acericorticis*.

LIFE-HISTORY.

The round of life of this species is not strikingly different from that of other Coccids, and is briefly as follows:

The young lice (Fig. 1, *c*) hatch in spring or early summer, walk about actively as soon as born, and settle along the ribs of the leaves (very rarely on the young twigs). They then insert their beaks and begin to pump up sap and to increase in size, a thin layer of a waxy secretion immediately beginning to cover the dorsum. In a little more than three weeks they have increased to double their size at birth, and undergo their first molt, shedding the skin, it is supposed, in small fragments. After this first molt, the waxy secretion increases in abundance and a differentiation between the sexes is observable. The males grow more slender and soon cease to increase in size, covering themselves with a thick coating of whitish wax. The pupa then begins to form within the larval skin, the appendages gradually taking shape, the head separating from the thorax, the mouth-parts being replaced by a pair of ventral eyes. A pair of long wax filaments is excreted from near the anus and these continue to grow during the life of the insect. It is the protrusion of these filaments from beneath the waxy scale which indicates

the approaching exclusion of the male. The posterior end of the scale is in this manner raised up, and the perfect insect backs out with its wings held close to the sides of its body.

Meanwhile the female larvæ have been undergoing but slight changes of form. They grow larger and also broader across the posterior portion, but remain flat and with but a slight indication of a dorsal carina. Just before the appearance of the adult males, they undergo another molt and change in color from a uniform pale-yellow to a somewhat deeper yellow with deep red markings. (Fig. 3, *a*, *b*, *c*.)

The males (Fig. 2, *c*) make their appearance from August 1 to September 15, issuing most abundantly about the middle of the former month, and their life is short, seldom exceeding two or three days. They copulate with the females and then die. The latter, soon after the disappearance of the males, gradually lose their bright-red markings and change to a deep-brown color. They grow more convex, and the dorsal layer of wax becomes thicker and more cracked. Before the falling of the leaves they migrate to the twigs and there fix themselves, generally on the underside. After feeding as long as the sap flows, they become torpid and remain in this condition until spring.

At the opening of spring the eggs develop with great rapidity and distend the body greatly, causing it to become convex instead of flat. The color is now yellowish, marked with dark brown, and the insect now absorbs sap with great rapidity and ejects drops of honey-dew. From the middle of May to the first of June the egg-laying commences. The eggs are deposited at the end of the body, in a nest of waxen fibers secreted from pores situated around the anus. This nest is attached to the posterior ventral portion of the body, and adheres somewhat to the twig. As the eggs are protruded into the waxy mass the posterior portion of the body is gradually raised up until it often reaches an angle of forty-five degrees with the bark. The egg-laying continues until on into July, and, after one or two thousand eggs have been deposited, the female dies. It is almost always within this period of egg-laying that the insect is noticed, on account of its large size, but more particularly from the conspicuous white cushion at the end of its body. After the death of the female, her beak breaks off and her body shrivels up, but remains attached to the twig by the cottony mass for a long time, often a year or more.

FOOD-PLANTS.

The ordinary food-plant of this species of bark-louse is the Soft or Silver maple (*Acer dasycarpum*), but previous to 1879 we had not only found it upon the other species of Maple, but also upon grape-vine, Osage orange, Oak, Linden, Elm, Hackberry, Sycamore, Rose, Currant, and Spindle tree (*Euonymus*). In addition to these plants Mr. Putnam mentions Locust, Sumac, wild Grape, Box-elder, Beech, and Willow. With regard to the specific identity of the individuals from all these different plants there is still room for doubt, though in 1875 we successfully transferred the species from Maclura and Vitis to Quercus. We wrote Mr. Putnam, under date of March 25, 1879: "In all essential external characters they are identical, and, until they are shown to be different by the character and arrangement of the secretory pores in the anal plate of the female, they must be assumed to be identical. It is this critical comparative study which would greatly increase the value of your work." This study Mr. Putnam failed to make, and summed up his account simply with the words: "I do not feel fully prepared to agree with Mr. Riley and Miss Smith in regarding all the *Pulvinariæ* found on

these plants as identical, but there is enough evidence to show that this insect is capable of thriving on quite a variety of food-plants, and in the cases where it has been directly introduced from the maple there is no question of its identity." We have also found what is evidently the same species doing considerable damage to the Woodbine (*Ampelopsis veitchii*) on our residence at Washington.

MODE OF SPREADING.

Owing to the wingless, degraded, and inactive character of the female and the limited capabilities of the young for extended locomotion, the problem as to how the insect spreads from one locality to another seems at first glance rather a difficult one. When we consider the great activity of the young lice, however, and their propensity for fearlessly crawling upon anything which happens to be in their immediate vicinity, the difficulty is lost sight of. We may recognize as aids in transportation (1) the transplanting of trees from infested localities to places free from this insect, (2) birds, (3) other insects, (4) winds, and (5) water. The first of these methods needs no comment. The second is undoubtedly one of considerable importance, though scarcely deserving the prominence given it by some writers. Mr. Walsh, in his first report as State Entomologist of Illinois (p. 41), in speaking of the oyster-shell bark-louse of the apple (*Mytilaspis pomorum*), made the following statement:

"In my opinion the only way in which, as a general rule, bark-lice can spread from tree to tree, when the boughs of those trees do not interlock, is by a few of the very young larvæ, when they are first hatched and are scattered over the limbs of a tree in such prodigious numbers, crawling accidentally onto the legs of some bird that chances to light upon that tree and afterwards flies off to another. I have long observed that when a tree first begins to be attacked by bark-lice, it is only particular limbs and branches that are at first infected, and that these will be swarming while the rest of the tree will be free from lice. And I have further observed that it is the lower horizontal limbs, or branches, or such as birds, with the exception of woodpeckers and nut-hatches, would most naturally perch on, that are first attacked. * * * If all the birds in the world were killed off, I believe that these bark-lice in a very few years would cease to exist."

This is an extreme view, and we have already shown (First Missouri Ent. Report, p. 15) how little the agency of birds is to be compared with that of insects. In the case of the species under consideration, the copious secretion of honey-dew attracts many honey-loving insects, such as bees, wasps, and flies, and these without doubt carry many of the restless young larvæ from tree to tree. Even the natural enemies of the bark-lice assist in this transportation, and Mr. Hubbard states (*American Naturalist*, May, 1882, Vol. XVI, p. 412) that the Coccinellid beetles *Hyperaspidius coccidivorus*, *Chilocorus bivulnerus*, and others, while feeding upon the young larvæ of orange scale-insects, carry many of them from one tree to another attached to their backs and legs.

Mr. Hubbard has more recently come to the conclusion that spiders are very important agents in the distribution of scale-insects, in fact, the most important of all agents, and as his remarks apply quite well to the insect and the topic under consideration, we quote from a letter published in Bulletin No. 2 of this Division, pp. 30–31:

I have reached the conclusion that spiders play a much more important role in assisting the spread of scale-insect than any other insects. From the beginning of my observations I have noticed that leaves which spiders had folded or webbed together

for their nests or lairs almost always proved infested with scale, if infested trees were found in the neighborhood. This I was at first inclined to attribute solely to the protection from enemies and parasites afforded by the web and presence of the spider. No doubt, where the source of infection is near at hand, this may give a sufficient explanation of the observed facts. Lately, however, I have been examining with great care a lot of one and two year old trees which I set out myself last March. The stock from which these trees were taken was to my certain knowledge almost absolutely free from scale-insect. At the time of setting, the weather was excessively dry and unfavorable; in consequence of which the trees, 600 in number, were badly checked, and to a great extent lost their tops and nearly all their leaves, so that the present growth is all new, produced during the past summer. Notwithstanding, I find, to my surprise, scale-insects beginning to appear on a large proportion of the plants. Upon some of them the insects have begun to spread over the branches, and the exact spot where the trouble began is no longer ascertainable. In a strikingly large number of instances I find two or more leaves bound together with silk and occupied by a spider, and the inner surfaces of these leaves completely coated with scale-insect, when not a trace of the insect can be found elsewhere upon the tree. Furthermore, this lot of trees occupies a position west and north of the remainder of the grove, in the path of the prevailing [S. E.] winds. The adjoining rows of older trees, on the southeast, are many of them quite badly infested with, for the most part, chaff-scale (*Parlatoria pergandii*), there being usually a relatively small number of long-scale (*Mytilaspis gloverii*) mixed with the other species. As is often the case, the proportions of this mixture of species remains quite constant throughout the infested part of the grove. Now, I find in the newly-infested young grove these two scales mixed in about the same proportions, so that no doubt exists in my mind as to the source of their infection. As to the manner in which it has been accomplished, I submit that if, as many persons think, the young lice are transported bodily by the winds, we would have had a very different distribution from that which exists upon the older trees. The larger and heavier young of the chaff-scale would have been carried to a less distance and in smaller numbers than the long scale. (There have been no unusual storms or very high winds during the past summer.) Again, in a chance distribution by the wind I can see no reason for any evident connection with spider-web shelters such as I have mentioned. Individual scale-larvæ do not, as far as I have observed, wander far in search of such protection, and do not need it until the colony becomes sufficiently numerous to attract enemies and parasites. The part played by winds is evidently a secondary one, inasmuch as nearly all the web-inhabiting spiders make use of the wind to carry themselves and their bridges of web from tree to tree, and the spiders transport as passengers upon their bodies the migrating larvæ of the scale insect.

The agency of winds is, as just stated, a secondary one of great importance in transporting spiders, and is of primary value in the carrying of infested leaves and twigs to greater or less distances. That the young lice are blown bodily from one tree to another by heavy winds, as formerly supposed, has been disproven by the experiments of Mr. Hubbard, who has shown that they will cling tenaciously to a twig or leaf under a heavy blast from a bellows or from the mouth.

NATURAL ENEMIES.

The Cottony Maple Scale is subject to the attacks of very much the same natural enemies as other scale-insects. A number of predaceous beetles feed upon the eggs and young larvæ. We have observed the common lady-bird, *Chilocorus bivulnerus*, engaged in this work, and also the Coccinellids *Hyperaspis signata* and *H. bigeminata*. In addition to these Putnam mentions *Anatis 15-punctata*, "the larva of a species of *Chrysopa*," and "the larvæ of two species of *Reduviidæ*."

The interesting lepidopterous insect *Dakruma coccidivora* Comstock, was originally bred from this bark-louse. Its larvæ construct tubular passages of silk and wax from one Pulvinaria to another on a thickly infested branch, and eat both the eggs and the waxy filaments which surround them. This insect and its curious habit were described at length by Professor Comstock in the annual report of this Department for 1879, pp. 241–243. It has been found preying upon Pulvinaria only in the vicinity of Washington, but in Florida destroys both a large *Lecanium*

on magnolia, a Coccid allied to *Dactylopius* and the common "Turtle-back scale" (*Lecanium hesperidum*).

During the past season, Miss Murtfeldt has noticed a harvest mite in great numbers feeding upon the eggs of this species at Kirkwood, Mo. From specimens sent to the Department, this mite seems to belong to the genus *Eupodes* and is allied to the European *E. hiemalis*. It is very minute and pale reddish-yellow in color. The body is divided into four distinct segments, two of which belong properly to the abdomen, the last one being the largest, the first the smallest, and the other two about equal in length. The division between the last two segments is a distinct, whitish, transverse line, while the others are indicated by slight lateral indentations and subdorsal impressions reaching to the lateral margin, of the same pale color. This is probably the same mite noticed by Miss Smith, and mentioned in her report previously cited.

Two true parasites are known to infest this scale. The first of these, *Coccophagus lecanii* (Fitch), is very common, and ordinarily infests the scales in great numbers. The adult insect is a minute, black, four-winged fly, marked with a crescent-shaped yellow patch in the middle of the body above. According to Putnam there are two broods of this parasite each season, the adults appearing in May and August. The infested lice become more or less inflated, finally turning black and becoming rigid. The females are most commonly infested, though Putnam states that he has bred the parasite from the male scale.

The second parasite was bred by Mr. Putnam after the publication of his article, and was described by Mr. Howard in his paper on the parasites of Coccids (Ann. Rept. Dept. of Agr., 1880, p. 365) as *Aphycus pulvinariæ*. This species seems to be rare and has not been bred since. It is minute, dull-yellow in color, with a dusky abdomen and with antennæ variegated with brown and white.

REMEDIES.

The principal remedies which have been proposed in the past are, briefly, heading in the tree, *i. e.*, cutting off the branches, and drenching with a solution of whale-oil soap or a 1 per cent. solution of carbolic acid. During the past season, however, we have recommended nothing but the kerosene emulsions treated of in a previous article, and these will undoubtedly give better satisfaction than anything else that can be used. The best time for spraying the trees will be while the young are hatching, late in May or early in June, and the apparatus described in the article on the Cottonwood Beetle can be used to the same advantage here.

THE CRANBERRY FRUIT-WORM.

(*Acrobasis vaccinii* n. sp.)

Order LEPIDOPTERA; Family PHYCIDÆ.

[Plate IX; Fig. 4.]

ITS HISTORY.

A worm seriously injuring the fruit of the cranberry,
the apple-worm (*Carpocapsa pomonella*) affects the apples,
fruit-worm (*Lobesia botrana*) grapes, has long been known
growers, but has hitherto remained undetermined. It is re

Packard (Report U. S. Geol. Surv., vol. 1878, p. 526), who gave an outline of the larva, and more fully in Bulletin No. 4 of this Bureau (pp. 28–29), where from a single rubbed female specimen of the moth we indicated that it probably belonged to the genus *Myelois*. A number of specimens of both sexes reared the past summer have permitted its positive reference to the allied genus *Acrobasis*, of which it proves to be a new species.

Mr. Smith, in his report which follows, has recorded some further observations on the habits of the species, and it is only necessary in this connection to summarize the facts.

The eggs, which, like typical Tortricid eggs, are flattened and conform more or less closely to the object to which they are attached, are generally laid singly, and usually in the calyx of the forming fruit, though sometimes on the surface of the young berry. As many as a dozen may be laid in a single calyx, however, when, as with Tortricid species, they often overlap each other. The larva works in the heart of the berry, and goes from one to another, ruining from three to four before attaining full growth, which is usually consentaneous with the ripening of the fruit. It stops up the entrance hole with silken web, and the affected berry turns prematurely red and finally shrivels and drops. Pale at first, it becomes green (with more or less pink) with age, and attains a length of about half an inch (Plate IX, Fig. 4, *d*).

It is found of all sizes during autumn, and a few later specimens persist till winter; but the bulk leave the ripening berries in September and October, and enter the ground, where each hibernates in an ovoid cocoon of silk, covered with grains of earth and sand (Plate IX, Fig. 4, *g*). The pupa (Plate IX, Fig. 4, *e*) is formed the following spring, and the moths issue quite regularly during the month of June or by the time the cranberries are forming.

The arsenical mixtures carefully sprayed during June and July in the manner already indicated in these reports, so as to reach the calyx cavity, will prove the most satisfactory preventive of this insect's injuries by killing the young larva as it attempts to eat its way into the berry; while experience would indicate that the natural growth of the berry, together with the effect of summer rains, will rid the fruit, as it matures, of whatever trace of the poison might prove injurious.

DESCRIPTIVE.

ACROBASIS VACCINII n. sp.—General color and appearance of *A. indiginella* Zell. (*nebulo* Walsh), but a somewhat smaller species, with primaries usually narrower. It may be distinguished by the following differences as compared with *indiginella*:

Average expanse, 15^{mm}. Colors of a colder gray, with less reddish-brown or tawny on the inner portions of primaries, and with the pale costal parts nearly pure white, so as to contrast more fully with the dark shades, and to more fully relieve the basal branch of the forked shade on inner part of first or basal line, this basal branch being also usually darker than the outer or posterior branch. The triangular costal patch from the basal line is obsolete. The transverse pale lines are less clearly defined, and the terminal is nearer the posterior border of the wing, *i. e.*, the median field is wider. The geminate discal dots are always well separated, and the inner one well relieved by the white which extends around it on the darker ground and often forms an annulus. The oblique shade from apex is less clearly defined.

Described from sixteen specimens of both sexes, reared from cranberries.

Egg.—About 0.4^{mm} long and 0.3^{mm} broad, ovate or almost circular, and flattened or plano-convex, the form varying with the surface of attachment, to which, while plastic, it partly conforms. Color olive-green or brown.

Larva.—Average length when full grown 10^{mm}. Convex above, flattened beneath. Surface of body minutely granulate, with a dull somewhat greasy appearance. Color varying from greenish-yellow to olive-green, reddish or brownish, being generally darkest towards the anal end. Head yellow, polished, somewhat lighter towards the

mouth, with the sutures of the clypeus slightly brown and the anterior angles of the head distinctly so; labrum, antennæ, and palpi white; mandibles yellowish at base, becoming blackish toward tip. Ocelli black. Cervical shield somewhat paler than the head, almost colorless anteriorly, its median line scarcely paler, without any markings except a brownish or blackish wart a little in front above the stigma. Anal plate of same color. Stigmata extremely small, except first and last pair, oval and pale brown. Piliferous warts only about one-half the size of stigmata, very pale brown and polished, each supporting a fine hair of a faintly yellowish color, of which those on the posterior row of warts are much the longest, and are directed forward. Similar long hairs are also on the head, thorax, around the margin of the anal plate, and along the sides of the body. Legs concolorous with body.

Pupa.—Average length 7^{mm}; brownish-yellow; stigmata brown. A dorsal, dark brown, transverse band anteriorly on last joint. Tip broad, almost straight, having a small tooth at each angle, and along its inferior edge four fine yellowish-brown bristles twisted and directed forward. Abdomen shallowly punctate.

In the series of American Phycids this species naturally follows *indiginella*, and it is at once distinguished from this, from *juglandis* Le Baron, and from *fallouella* Ragonot, its nearest European ally, by the obsolescence of the triangular costal patch.

Mr. Grote, in his last "Check List of North American Moths," has suppressed *Acrobasis* Zeller and referred this little group of Phycids to "*Phycis* Haw." He has also made *juglandis* a variety of *indiginella*. Both acts are totally unjustifiable, and illustrate the general untrustworthiness of his work. *Phycis*, as a genus, was founded by Fabricius, and Haworth's *Phycis* comprised nearly all the species of the family, and the name has long been abandoned in modern more exact classifications, while the full descriptions, figures, and larval histories of *indiginella* and *juglandis* in our Fourth Report on the Insects of Missouri (pp. 38–43) prove beyond all question the specific value of both.

There is a *Nephopteryx vacciniella* Zeller on *Vaccinium uliginosum* in Europe, and for this reason we have dropped the conventional termination in the name of our species.

THE LARGER WHEAT-STRAW ISOSOMA.

(*Isosoma grande* Riley.)

Order HYMENOPTERA; Family CHALCIDIDÆ.

[Plate VII, Figs. 2, 3; and Plate VIII, Figs. 3, 4.]

While the phytophagic habit in the genus *Isosoma*, as exemplified in the common joint-worm, has of late years been fully accepted and considered proved in this country, it still meets with objectors in Europe, who maintain, on the general principle of unity of habit in the same family, that it must be parasitic. While we felt no doubt on the subject ourselves, we yet deemed it desirable to get such absolute proof, by watching the oviposition of the female and the development, from the egg on, as could not be controverted, and would leave no possible room for any further question in the matter. We therefore particularly instructed one of our field agents, Mr. F. M. Webster, to carefully make the necessary field observations, and it will be seen from his report, which follows, that he has succeeded in doing so. We may here mention that our own previous observations on *Isosoma tritici*, in which we have examined the larvæ of various ages invariably feeding in the stalk with no sign of other insect that it was feeding on, were, in our judgment, amply sufficient to settle the question; but Mr. Web-

ster has been able to witness the female in the act of ovipositing, and from specimens received from him we have been able to fully verify the conclusions that we previously came to. The matter is of no slight economic importance, as already shown by Harris, Fitch, and Walsh; for, on the assumption that the genus is parasitic, it will be manifestly unwise to burn the stubble in which many of the larvæ hibernate, or to burn the straw after the grain has been harvested, since in such straw there also remain a large number of hibernating individuals. If, however, as it is now abundantly proved, the genus is phytophagic, these measures at once acquire importance as means of averting future injury.

Mr. Webster's observations have been made, not only upon *tritici* Riley, but, as will be seen from his report, also upon another species of larger size. This we have recently described under the above name, in the December (1884) number of the Bulletin Brooklyn Entomological Society (Vol. VII, p. 111) from which we reproduce the description:

ISOSOMA GRANDE n. sp.—*Female.*—Length of body 4.2^{mm}, expanse 7.6^{mm}. Antennæ rather more slender and less clavate than in *tritici* and but half the length of thorax. Thorax with the mesonotum slightly more rugulose; wings larger and less hyaline than in the winged specimens of *tritici*, the veins extending to outer third, the submarginal nearly four times as long as marginal; legs with the femora less swollen. Abdomen not so long as thorax, stouter than in *tritici*, ovate-acuminate, approaching typical *Eurytoma*. Less hairy than *tritici*, especially about the legs, the hairs of abdomen being less numerous, less regular, and shorter. Coloration similar to that of *tritici*, but brighter and more highly contrasting, the pronotal spot larger and brighter yellow, the pedicel of antennæ yellow and the femora with a definitely limited suboval, yellowish spot below, near the tip, extending two-fifths the length of femur on front pair, smaller on middle pair and still shorter and less definite on posterior pair.

Larva.—Greenish-yellow in color. Average length, 6^{mm}; otherwise of same proportions and structure as in *tritici*.

Pupa.—Average length 5^{mm}. Except in larger size and ample wing-pads undistinguishable from that of *tritici*.

Described from twenty-four females, reared from wheat-stems in June, and taken by Mr. F. M. Webster at La Fayette, Ind. * * * Its larger size, stouter build, aside from the other characters mentioned readily distinguish it, however; while from *hordei* Harris, *vitis* Saunders, and *elymi* French, it is still more readily distinguished.

The figures which we have prepared (Plate VII, Figs. 2, 3; and Plate VIII, Figs. 3, 4) very well illustrate the mode of oviposition, and the larval, pupal, and adult characters. The ovipositor is thrust in an almost straight line through the wall of the straw and reaches to the heart or pith, without, however, penetrating it. The length of the inserted parts generally exceeds 1^{mm}, the entire length of the ovipositor being about 1.6^{mm}.

The egg, as carefully studied in females that were ovipositing, is of the ordinary ovoid form, but characterized by a pedicel variable in length but generally twice as long as the bulbous or ovoid portion. Its apical end is also furnished with a distinct hook, the function of which is, in all probability, to hold it in the plant tissue while the ovipositor is being withdrawn.

It may be here stated as an interesting fact that of the specimens so far reared both of *tritici* and *grande* all are females, and whether or not there is any dimorphic relationship between these two forms is a question which future observations alone can decide. The probabilities are, however, that there is no connection between them; for, on the assumption that they represent alternate generations, we should expect the one or the other to comprise both sexes.

SILK-CULTURE.

Until the middle of July of this year the work and correspondence relating to sericiculture were kept up by the ordinary force of the Bureau. In response to applications, silk-worm eggs were sent in upwards of twelve hundred packages to some two hundred persons, most of whom were supplied with samples of six different races for comparison.

Reports have been received from very few of these, so that it is impossible to say what the general result of their experience has been.

In August, 1883, it was found necessary to issue a fourth edition of our Manual of Instruction for the Production of Silk (Special Report No. II of this Department). Of the one thousand copies then printed, more than nine hundred have been sent out in answer to applications from all parts of the country.

The work of the Bureau in the distribution of literature, silk-worm eggs, &c., which has been maintained without any special Congressional aid heretofore, can this year be more easily and extensively carried on, owing to an act approved June 5, 1884, "for the encouragement and development of the culture and raising of raw silk," which appropriated $15,000 for this purpose. Under this act, Mr. Philip Walker was appointed a special agent, and will, with the necessary clerical force, give his entire time to the work of the Silk Division of this Bureau.

The operations necessary to the manufacture of raw silk are being studied as their importance demands, and it is our intention to establish a small experimental filature on the grounds of the Department in order to advance the study of this subject.

A most important feature in the successful raising of silk-worms, and one which experience teaches should receive the attention of any Government wishing to encourage the industry, is the production of healthy eggs, for distribution among sericiculturists. The Mulberry Silk-worm is subject to two diseases which at different times have wrought havoc in Europe and the East. These are the pébrine and the flacherie. They are caused by the presence of minute parasitic organisms, the nature of which was, for several years prior to 1870, thoroughly studied by the French savant, Pasteur, under the direction of the Academy of Sciences. While he has found no means of curing these diseases once they have appeared, he has given us a method of preventing their passage from one generation to another, and experience has shown that his methods are satisfactory. The methods set forth by him and the rules laid down for the production of healthy eggs are rigorously observed in all sericicultural countries of Europe, although the eggs bring a higher price as the result of the great care entailed by these processes.

Feeling the importance of distributing only such eggs as are known to be pure, and on account of the rarity of eggs produced in America after Pasteur's processes, the eggs for distribution the coming winter have been purchased from reliable French houses, and are known to be of good stock.

As bearing on the measures taken by other Governments in aid of silk-culture, a report made to his chief by Mr. Agostini, secretary to the consul-general at Paris, and relating to the French experimental stations, will prove of interest in this connection, and is reproduced farther on.

We would wish again to call your attention to a subject to which we

referred in our report for the year 1878. At that time, referring to the lack of a home market for cocoons, we made the following suggestion:

"As a means of meeting the difficulty, I have urged, and would urge, that Congress give to this Department the means to purchase, erect, and appoint with skilled hands, on the Department grounds, a small filature or reeling establishment. In such an establishment reelers could be trained, and the cocoons, at first raised from eggs distributed by the Department, could be skillfully reeled and disposed of to our manufacturers. A market would thus be formed for the cocoons raised in different parts of the country, and a guarantee be given to those who choose to embark in silk-culture that their time would not be thrown away. All industries should be encouraged in their infancy; and for the first few years, or until the silk industry could be considered well established, the cocoons should be paid for at the European market rate, plus the cost of reeling. * * * This last should be looked upon as a premium offered by the Government to the raisers, in order to stimulate the industry until such time as the reeling might be safely left to private enterprise, when Government encouragement could be withdrawn."

The correspondence of the Bureau very fully shows that, once a home market for cocoons has been established, one of the great obstacles now existing to success in silk-culture will have been removed.

There is but one way to create this home market, and that is the erection of filatures for turning the cocoon into raw silk. The great obstacle to this, the high price of labor, will, we have some reason to believe, be largely removed by recent improvements in the automatic silk-reeling machinery invented by Mr. E. W. Serrell, jr., of New York, now resident in the south of France. Referring to this machinery, Mr. Consul Peixotto, of Lyons, France, wrote to the Department of State, under date of October, 1880, as follows:

"But how can we overcome the competition of Europe and Asia with regard to labor? I am happy to be able to answer this question here and now.

"In the month of June last, recommended by the Department of State, which under the present administration has done so much to encourage our home manufactures and develop our foreign trade, and provided with letters by the Commissioner of Agriculture, there came to Europe a young American engineer, who, before leaving home, had already given much time and study to the subject, and who since has devoted several months to visiting and carefully inspecting the principal filatures of France and Italy. This gentleman, Mr. Edward W. Serrell, jr., of New York, believed it possible to invent machinery which, by the use and application of *electricity*, would not only overcome existing difficulties, produce a superior quality of thread, but solve at the same time the all-important labor question, and render silk-reeling in the United States as possible and profitable as anywhere else in the world.

"It affords me very great satisfaction to say that, in my judgment, Mr. Serrell has at length been successful, and that very shortly this fact will be abundantly and incontestably proven, both for the now unhappy and rapidly-declining silk-reeling industry of Europe, as well as for the, from an American point of view, still more important and valuable interest, the successful planting of silk industry in the United States in all its ied stages and branches, from the mulberry tree, the *magnanerie* or ching-house, the *reeling-mill*, to a still higher perfection than what we e already attained in the fabrication of tissues. What the cotton-

gin has done for cotton, which with us ninety years ago hardly had a commercial value, the Serrell invention may yet do for silk, and the United States become as pre-eminent for the latter and costlier product as for the former and cheaper culture."

We had the pleasure of meeting Mr. Peixotto last summer at Lyons, and found that he has yet the same faith in the Serrell invention, and the present favor with which this machine is regarded by the ultra-conservative merchants of Lyons would seem to bear Mr. Peixotto out in his prophecy.

Letters are constantly being received from all parts of the country urging that the Government use the means at its disposal to assist in some way the creation of a home market.

Some private attempts have been made to establish filatures, and the most successful seems to be that of Mr. J. Herberlin, of New Orleans.

Referring to his work for this year, he writes: "I continue with great success in the sericicultural industry. My crop of cocoons was abundant. I have made choice grain, of which I keep a certain quantity to distribute. My spinning-mill is in operation and using the products of 1884. I persist in this industry, and strive to spread it, as it promises a great increase of resources to the United States. I can raise on the leaves furnished by my mulberry plantation, over three millions of worms. In this, its second year, I hatched sixty ounces of eggs, and that has produced 5,117 pounds of cocoons, and every year I can do more. * * * I employ in my spinning-mill nineteen hands, and during the time of silk-worm raising one hundred and twenty to one-hundred and twenty-five persons."

RUST OF THE ORANGE.

By H. G. HUBBARD, *Special Agent.*

[Plate I; and Plate IX, Fig. 5.]

NATURE OF RUST.

Discoloration of the Fruit.—The brownish discoloration of the rind of oranges, familiarly known under the name of "rust," has, since the production of this fruit became an important industry in Florida, given great concern to the producers, and occasions annually serious loss by affecting injuriously the salableness of the fruit. In appearance the rust varies from a light or dark-brown stain beneath the cuticle, to a rough incrustation resembling an exudation of resinous gum upon the surface. In the former case the golden color of the ripe orange is more or less obscured, and in the latter entirely destroyed by the discoloration. When entirely coated with rust the surface becomes finely chapped and roughened, giving to the unripe fruit a likeness to russet apples.

The season during which rust makes its appearance includes nearly the entire period of growth of the fruit, beginning in early summer, when the fruit has attained less than one-third its full size, and continuing late into autumn. Its most rapid increase is, however, in August and September, as the orange approaches maturity. Rarely is there any real increase after the rind begins to ripen, although the discoloration usually attracts attention just at this time, and frequently occa-

sions unnecessary alarm. On the contrary, there is always a perceptible brightening as the fruit attains its full color, and oranges slightly affected, or affected very early in the season, when fully ripe show but little trace of rust.

Is Rust a Fungus, or an Exudation of Gum?—The term "rust" is very indefinitely applied to a great variety of plant diseases, some of which are clearly due to the presence of fungi, and others are considered pathological conditions of the plant, attributable to, for the most part, unknown or conjectural conditions of soil or climate.

A good example of the first class is found in the common and very destructive rust of the fig. Any one who will take the trouble to examine with a good glass the brown discoloration upon the surface of the leaves, may easily detect the sacks, or asci, of the fungus, filled to bursting with the spores, or pouring them out upon the surface.

Nothing of this kind is seen upon the leaves or rusted fruit of the orange. A microscopic examination of the fruit-rind reveals no forms of fungus, but shows the oil-cells to be more or less completely emptied of their contents, and the outer layers, the epithelial cells, clogged with brownish resin, or entirely broken up and divided by fissures, which permit evaporation of the fluids from the underlying cells. The rind of rusted fruit, therefore, shrinks and toughens, and loses by evaporation or oxidation the greater part of its essential oil.

THE ORIGIN OF RUST.

Reasons for considering it the Work of a Mite.—If we examine critically with a hand lens of considerable magnifying power the surface of a rusted orange, we will find here and there in the depressions, groups of minute white filaments adhering closely to the rind. Carefully transferring one of these filaments to the stage of a compound microscope, and applying a power of several hundred diameters, the character of the object is clearly shown. It is the cast skin of an insect.

If the examination chance to be made in winter, when the fruit is ripe, the number of these exuviæ will not be strikingly great. But if made in autumn or late summer, the surface of every orange showing rust will be found thickly sprinkled with them, and we shall be forced to conclude that we have before us the relics of a numerous colony, which at some former period infested the fruit.

Extending the examination to fruit that as yet shows no indication of rust, we will, if the season is not too far advanced, obtain abundant confirmation of this conclusion, and find these colonies in the full tide of their existence. The former occupants of the cast skins prove to be elongate mites, of honey-yellow color, too minute to be seen as individuals with the unassisted eye, but visible in the aggregate as a fine golden dust upon the surface of the fruit.

The Mite on the Leaves.—Having tracked the mite by means of its tell-tale exuviæ, and detected it at work upon the fruit, if we turn our attention to the leaves it needs no prolonged search to discover it here also, and in even greater abundance. In fact, it is evidently upon the leaves that the mites exist and propagate throughout the year; for not only are they found upon fruiting trees, but upon plants of all ages, in the nursery as well as in the grove.

Nothing resembling the rust of the fruit follows their attacks upon the leaves. Each puncture of the mites gives rise to a minute pimple or elevation, until the surface of the leaf becomes finely corrugated, l es its gloss, and assumes a corroded and dusty appearance.

This tarnished appearance of the foliage is very characteristic, and remains, a permanent indication of their depredations, after the mites themselves have disappeared.

First appearance of Mites on the Fruit.—From the time when the cellular structure of the rind has completely developed, and the oil-cells have begun to fill, until the fruit is far advanced in the process of ripening; in other words, from early spring until late in autumn, it is liable to attacks of the mites, but it is in the intermediate period of its growth that the fruit offers conditions most favorable to their increase.

Attacks of the Mite always followed by Rust.—The evidence that rust follows as a sequence upon the depredations of this mite is circumstantial rather than direct, but it is also cumulative. Oranges marked and kept under observation, but allowed to remain upon the tree, have in all cases rusted after being overrun by the mites. Those upon which no mites made their appearance remained bright to maturity.

A very large number of observations show a close connection between the occurrence of mites upon the foliage and rust on the fruit, so that it may be stated as a rule, when the foliage of a tree retains its gloss, the fruit also will be bright, and, conversely, when the condition of the leaves indicates the presence of mites in great numbers, the fruit will be discolored.

This is found to be true, not only of the entire tree, but of restricted portions. Thus the upper, the lower branches, or one side of an orange tree may produce rusty fruit while that on the other parts of the tree remains bright. In such cases there will always be a marked difference in the condition of the foliage upon the two portions, and the leaves surrounding the affected fruit will indicate more or less clearly the work of the mites.

Other and perhaps more conclusive reasons for considering the mite responsible for rust will be better understood when the habits of the mite itself have been considered.

Interval between the Disappearence of the Mites and the Appearance of Rust.—As has been already indicated, the mites do not permanently infest either the surface of the leaf or the rind of the fruit, but wander off to fresh feeding-ground when, through their combined attacks, all the accessible oil-cells have been emptied of their contents, or the tissues have been too much hardened by advancing maturity to be easily penetrated by their beaks.

The effects of their punctures upon the cellular structure of the plant, however, continue after their departure, and upon the fruit, rust develops with a varying interval, depending possibly upon the relative humidity of the air. Usually the discoloration is very apparent after the lapse of a week, and the rind continues to harden indefinitely, or as long as it is exposed to the air.

THE RUST MITE.

Description.—The so-called rust insect (Plate IX, Fig. 5, *a b*) is a four-legged mite, honey-yellow in color, and about three times as long as broad. The body is cylindrical, widest near the anterior extremity, and tapers behind, terminating in two small lobes, which assist the animal in crawling and enable it to cling firmly to the surface upon which it rests. The front is prolonged in a conical protuberance, which appears to be composed of two closely-applied lobes. The upper surface at its widest part is marked on each side with shallow depressions, which are faintly prolonged on the sides and reach nearly to the terminal lobes. The

abdomen consists of about thirty segments. The beak, a short, curved tube, is usually retracted between the organs of the mouth. The latter form a truncated cone, concealed from above by the projection of the front, and difficult to resolve into its component parts. Under high powers it can be seen to consist of at least two thick lobes, which in the living mite have a reciprocal forward and back movement.

The two pairs of legs are placed close together, at or very near the anterior extremity, and project forwards. They are four-jointed, and terminate in a curved spine, with opposing bristles. (Plate IX, Fig. 5, *c.*) The intermediate joints bear one or two very long, curved bristles. Several fine bristle-hairs, arising from the under surface of the body, curve upwards at the sides, and two very long bristles at the caudal extremity ,curving downwards, are trailed after the mite as it crawls.

The length of the adult mite is 0.14^{mm} ($\frac{5}{1000}$ inch). The young do not differ essentially in structure from the adult mites, but are thick and short, almost cordiform, and the legs are very short.

The eggs, which are deposited singly or in little clusters upon the surface of the leaves, are spherical, transparent, with a yellow tinge. Their diameter is more than half that of the mite at its widest part, and they probably increase in size by the absorption of moisture after they are laid, otherwise the body of the mite could not contain more than three or four fully-developed ova. The embryo is curved within the egg, its head slightly overlapping the tail. (Plate IX, Fig. 5, *d.*)

Life-history.—In hot weather the eggs hatch in four or five days, but in winter their development is more or less retarded by cold, although it is not entirely arrested even by frost, and the duration of the egg period seldom exceeds two weeks.

The young mites are bright, translucent yellow in color. Within a week or ten days they undergo a metamorphosis or molt, during which the animal remains dormant for about forty-eight hours. With its legs, which are placed close together, and stretched out in line with the body, and with its two-lobed anal proleg, it clings closely to the surface of the leaf. The form becomes more elongate and spindle-shaped. The body of the transforming mite separates from the old skin, which becomes pellucid and empty at the extremities, and finally splits longitudinally, releasing the renovated mite. The rejected pellicle is left firmly adhering to the surface on which it rests, but is in time removed by the action of the weather, and much sooner from the leaves than from the rind of fruit.

The adult mite is slightly darker than the young in color, and becomes more opaque as it grows older. No sexual differences have been distinguished, nor has the act of coupling been observed.

Owing to the difficulty of confining the mites without interfering with the conditions necessary to their existence, it has not been possible to determine the duration of their lives. It is, however, safe to conclude that they live several weeks after reaching the adult stage. The number of eggs deposited is also uncertain, but it is probably not abnormal, and the enormous populousness of their colonies must be attributed to rapid development, and comparative immunity from enemies and parasites, rather than to excessive fecundity.

Food.—This evidently consists of the essential oil which abounds in all succulent parts of the orange and its congeners, and which the mites obtain by penetrating with their sucking beaks the cells that lie immediately beneath the epidermis. That they do not feed upon the chlorophyl, is shown by the color of their intestinal contents, which has no

tinge of green, but a clear yellow, unmistakably indicating the source from which it came.

Wandering Habits.—While engaged in feeding, the mites remain quiescent for a length of time varying from a few minutes to half an hour. They then move on a short distance and again become motionless. If disturbed they have a habit of erecting themselves upon the leaf, clinging to its surface only by the anal proleg.

When dissatisfied with their surroundings, or when food becomes scarce, they wander restlessly about, and undoubtedly travel to considerable distances. Their rate of progress on a smooth surface is quite rapid, and amounts to 10 or 12 feet per hour. It is therefore not surprising to find them changing their position frequently; disappearing suddenly from one portion of a tree, and appearing as suddenly in great numbers upon another and distant part of the same tree.

It is not to be understood that the mites show any concert of action in moving their colonies, or that they are in any other sense gregarious than that they are usually found very thickly scattered over those parts of an infested plant which offer favorable conditions for their support. Thus the new growth of many orange trees becomes occupied or infested by them as rapidly as the leaves fully mature, and the number upon a single leaf may be estimated by many thousands.

Numerical abundance.—The following examination made in January will give an idea of the extent of the brood during the coldest part of the Florida winter.

From a large number of leaves of late autumn growth, one was selected, which showed an even distribution of mites upon its surface. An area of one square inch was accurately marked out with a needle, and subdivided into sixteen equal squares. The number of mites and their eggs upon four of the small squares, taken at random, was counted, and found to aggregate 1,142.* This gives for the square inch under observation 4,568 mites. The leaf was then cut into squares and triangles, and was found to cover 15 square inches upon a sheet of paper.

On the supposition that the experimental square inch gives a fair average, the number of mites upon the upper surface of this leaf was 68,520. Certain portions, not exceeding one-quarter of the whole, were however more or less thinly populated. Deducting, therefore, 27 per cent. from the above, we have 50,020 mites, the approximate population of the upper surface. The under side of the leaf was less thickly infested, but the number of mites may be estimated as one-half that of the upper face, or 25,000. Thus the number of mites and their eggs, upon a single leaf, is found to reach even in mid-winter the enormous sum of 75,000.

In early summer, when the breeding is active, these estimates will be greatly exceeded. At times an orange tree may be so completely infested with the mites that, of its thousands of leaves, very few can be found free from their presence. If then, we attempt to calculate the number that may exist contemporaneously upon a bearing tree, we find it represented, not by millions but by billions, and the figures obtained convey no definite impressions to the mind.

Preference shown for half Shade.—An examination made on a bright, sunny day shows that, while the mites cannot long endure the direct light and heat of the sun, they also avoid dark shade. At midday they are more abundant upon the under side of exposed leaves, and although

* The number of eggs exceeded that of the mites, a phenomenon not often observed, and which may be attributed to unusually cold and unfavorable weather at the time of the examination and for several weeks previous.

they at all times show a marked preference for light, they desert those parts of leaf or fruit upon which it falls brightest. On a leaf partially exposed to the sun, the mites congregate near one edge in the morning, and in the afternoon cross to the opposite side of the same surface, following the shifting shade which, by reason of its curvature, the edges of the leaf throw upon one side or the other.

Rings of Rust on Fruit.—On the fruit, this preference of the mites for half shade, causes a phenomenon which will be recognized as very common on rusty oranges. This is the occurrence of rust in a well-defined ring obliquely encircling the orange, as the ecliptic does the earth. The rust ring is seen most plainly on fruit from the upper portion and south side of a tree when it stands with others in a grove, and will be found to mark the band of half shade, between the portion of the orange most directly exposed to the sun's rays and that in densest shadow. The surface covered by this penumbra band is precisely that upon which the mites gather most thickly in the middle of the day. Here their attack upon the rind will be most severe and its after effects most noticeable. (Plate I.)

There is also observable in rusted fruit a marked difference in the amount of discoloration upon the opposite sides. Even where no plainly-marked ring is visible, the side of the fruit which, upon the tree, was turned towards the sun, frequently presents a bright spot, and the opposite side an area of lighter bronze, with less sharply defined boundaries.

These facts, taken in connection with the observed habits of the mites, may be regarded as the strongest evidence showing a connection between rust and their attacks upon the fruit.

Influence of Weather.—It has been already observed that the hatching of the eggs, although retarded, does not cease in cold weather, and that the breeding continues throughout the year. Frost, which is sometimes severe enough to kill the adult mites, does no injury to the eggs, and the severity of a winter has little if any effect upon the prevalence of the mites during the following summer. In droughts, however, there is some evidence that many of the eggs dry up and are exterminated. The extremely dry seasons of 1881 and 1882 have been followed in the winter of 1882–'83 by the brightest crop of fruit that has been known for several years.

Agencies which assist in the Distribution of the Mites.—The activity of the mites and their readiness to climb upon anything they meet in their path, renders it evident that any living creature which passes from one tree to another is competent to transport the mites with it. The tail feathers of birds must sweep thousands from the surfaces of the leaves, and spread them from tree to tree or from grove to grove.

So readily do they relinquish their hold when brought into contact with a moving body, that the point of a needle swept across the surface of an infested leaf will usually be found to have several mites adhering to it.

The same agencies which assist in the spread of scale-insects undoubtedly serve to scatter the mites. Not only do they climb readily along the web of spiders, but they may frequently be seen upon the bodies of the spiders themselves, which do not seem to be at all disturbed by the restless movements of their little attendants.

The wandering habit of spiders is well known. Their method of bridging great distances by casting out hundreds of feet of silken line, to be wafted by the winds and caught in distant trees, has often been noted. There is little doubt that of all other modes of dissemination,

both of scale-insect and rust-mite, that of transportation by spiders is the most important, the most constant, and regular. The spiders bear with them upon their hairy bodies the young bark-lice and the adult mites, conveying them in their own migrations to distant points, and colonizing them under their protecting web whenever they chance to select the leaves of a citrous plant as their resting place.

And here is found the solution of that puzzling influence of the wind so often remarked in the case of scale-insects, and which has led many to believe that they are disseminated directly by this agency, and therefore spread most rapidly in the direction of the prevailing currents.

Spiders of the web-making kinds are necessarily dependent upon the wind in making long voyages. The warm southeasterly winds of spring excite in them the migratory instinct, and at a time when the orange-trees are swarming with the quickened life of scale and mite, from a thousand projecting points of branch or leaf, the spiders are sending out their lines of rapid transit, and are bearing with them "on the wings of the wind" the seeds of mischief to the orange-grower.

RAVAGES OF THE RUST-MITE.

The Mite known only upon Plants of the Citrus Family.—The Rust-mite attacks indiscriminately the various species of Citrus in common cultivation, but has not been observed to feed upon plants of any other genus. It is found upon the Lime, Lemon, Citron, Shaddock, Bigarde, and Tangerine, and none of the varieties of the Orange are known to be in any degree exempt.

Upon the leaves and fruit of all these species of Citrus, the effects of its attack are essentially the same, although the rust is most noticeable on the sweet and bitter Orange.

Effect of Attacks upon the Foliage.—Like certain internal animal parasites, which feed only upon the fat of their hosts, and do not touch its vital organs, the mite does not destroy the vital functions of the leaf. The chlorophyl is untouched, and the plant is robbed of a portion only of its essential oil. The leaves never drop, no matter how severely attacked, but there is loss of vitality, and the growth of the plant is checked. This is especially noticed in young trees, which are frequently overrun by the pest in early summer, and during the remainder of the year make little progress.

The foliage of affected trees wears a dry, dusty appearance, and loses color. The leaves are without gloss, and become slightly warped, as in droughts.

Rusted Fruit.—If severely attacked by rust before it has completed its growth, the orange does not attain its full size. Very rusty fruit is always small. Its quality is, however, improved rather than deteriorated. The toughened rind preserves it from injury and decay, prevents evaporation from within, and carries the ripening process to a higher point.

Rusty oranges can be shipped without loss to great distances. They keep longer, both on and off the tree, and when they reach the Northern markets are superior to the bright fruit in flavor. Consumers not being aware of this fact, however, prefer the latter, and the reduced price of the bronzed fruit more than offsets to the producer its superior keeping and shipping qualities.

Introduction and Spread of the Mite.—Of the origin of the Rust-mite, whether native or introduced, we as yet know nothing. As far as has been observed, it is not found upon the wild orange trees in Flor-

ida, although it attacks them indiscriminately with others of the Citrus family, when transplanted to open ground, and it may exist upon them in small numbers in their native swamps.

It is said that a few years ago rust was entirely unknown, but the orange industry in this State is of such recent growth that attention has not long been directed to this matter. When but little fruit was produced, occasional discolorations of the rind would naturally pass unnoticed.

Periods of Increase.—As is the case with most invasions of insects, the pest, although increasing rapidly for a time, is likely to reach a maximum in a few years and afterward decline. This has been the experience in former years with scale-insect, and is attributable to comparative immunity from enemies and parasites at the outset. As the number of their enemies increases, that of the destroyers diminishes, until in time a state of equilibrium is reached, which is only disturbed temporarily by the changing conditions of climate, or other and obscure causes.

It seems probable that the Rust-mite has reached or is already past the period of maximum destructiveness, and that succeeding years will witness its subsidence. The mite has at present few enemies, and of these the most important are unfortunately not abundant. They give promise, however, of greater efficiency in future, as they belong to families many of whose members are as prolific as the Rust-mite itself.

Geographical Distribution.—Rust appears to be known upon the orange only in Florida. Within the limits of the State, however, its presence is universal. No section, whatever claims may be made to the contrary, is exempt.

REMEDIES.

Influence of Soil and Methods of Cultivation.—The effect upon the prevalence of rust of various systems of cultivation and of applications to the soil, for the purpose of changing its nature or supplying assumed deficiencies in its composition, has been the subject of endless discussion, and of experiments affording negative or conflicting results, which cannot profitably be reviewed here.

Suffice it to say, no method of combating rust by special treatment of the soil, or other indirect action through the plant, has been proven effective. By forcing with fertilizers or high cultivation, no improvement is effected in the color of the fruit. This depends, not upon the condition of the tree, but rather upon the number of the mites, which is, in fact increased by an abundant supply of new growth and a constant succession of fresh and vigorous leaves.

It seems, however, to be an established fact that the fruit is less liable to rust upon low than upon high lands. Groves planted upon moist, rich hammock or clay soils produce, as a rule, brighter fruit than those upon high, sandy pine lands.

This result is commonly attributed to the abundance of moisture in low ground; but it may be more directly due to the denser shade afforded by a more vigorous foliage and reduced radiation from a darker soil. In the native wild groves, which are always densely shaded by forest, neither rust nor mites are found, and the same immunity is enjoyed by cultivated trees planted in similar situations.

Preventive Measures.—It is not at present possible to suggest any preventive measures that can be universally adopted, nor are precautions likely to avail much against an enemy which already exists, even if it does not always make its presence known, in almost every grove and nursery in the State.

Those who advocate forest culture for the orange may justly claim for it the advantage of affording comparative immunity from rust; but a discussion of the merits and demerits of this and other systems of cultivation must be left to the horticulturist.

It may, however, be proper to suggest that where isolation is practicable, much can be accomplished towards the exclusion of such pests as the Rust-mite and the scale-insect by properly arranged natural screens. Narrow belts of original forest, with its undergrowth, may be left, at least on the southeast side of the grove, or, on high land, the tall pines may be supplemented by hedge-rows of the native holly, the jujube, or other evergreen shrubs, which thrive upon uplands in the South.

Such wind-breaks not only protect the bearing trees and fruit from the whipping action of southeasterly gales, but afford the best and only hindrance to the spread of mites and bark-lice, prohibiting their direct importation upon spiders and other insects, through whose aid they are disseminated.

Application of Insecticides.—As the Rust-mite lives exposed upon the surface of the plant, neither inhabiting a gall, nor making any protective covering for itself or young, it is not a difficult matter to reach it with insecticides thoroughly applied. The adult mites are very delicate, and readily succumb to applications of moderate strength, but the eggs possess much greater vitality, and require for their destruction, solutions of great penetrating power. The immature mites, while undergoing their transformations, are also difficult to kill, and appear to be specially protected by the old skin, within which their changes take place.

These three stages, the adult, the molting young, and the egg, exist simultaneously at all seasons of the year. The development of the mite has been shown to be very rapid. The eggs hatch in four or five days, the time extending rarely, in winter, to two weeks. Molting takes place in seven to ten days, and lasts two days. Eggs are probably laid in a few days after the molt.

In applying remedies, it follows from these data that if the mites alone are killed, and their eggs left alive, young mites reappear immediately, adults are found in ten or twelve days, and fresh eggs are deposited within two weeks. If the molting mites are also left alive, very little good can be accomplished, as a fresh crop of adult mites and eggs will be produced in two or three days.

In combating Rust-mite the difficulty in killing the eggs compels us to adopt one of two alternatives. We must either use powerful insecticides, in solutions even stronger than are required for scale-insects, or else make several applications, at short intervals, of washes competent to kill the mites only. In this way the trees may be freed of mites, by killing the young as they hatch, and not allowing any to reach the adult stage and produce a fresh crop of eggs.

The following substances have been tried and their effects noted upon the mites and their eggs:

Whale-oil Soap.—The action of this substance upon the mites is peculiar. A trace of it in solution causes them to relinquish at once their hold upon the leaf. All other liquids that have been tried, even if they kill the mites, increase the tenacity with which they cling to its surface. All the free* mites are at once removed from leaves dipped in a solution of 1 pound to 100 gallons of water. Stronger solutions are, however, required to kill them or their eggs and the dormant (molting) young.

* This term includes adults and young not dormant, or undergoing transformation.

The following experiments made in the laboratory upon infested leaves, show the action of solutions of various strength. In order to retain the mites upon the leaves, the liquids were beaten into foam, which was spread evenly upon both surfaces, care being taken to wet every part of the leaf.

(1.) Solution: 1 pound to 100 gallons. Free mites washed from the leaf with spray and collected upon blotting paper, began to crawl away as soon as dry, and showed no injury the following day. Eggs and molting young remained upon the leaf and were not affected.

(2.) Solution: 1 pound to 50 gallons. Applied in foam. Free mites in great part killed. Molting young and eggs not killed.

(3.) Solution: 1 pound to 32 gallons. Adult mites all killed. Molting young in part killed. Eggs not killed.

(4.) Solution: 1 pound to 16 gallons. Adult mites all killed and shriveled, in two or three hours. Molting mites, about 80 per cent. killed. Eggs, a large percentage killed.

(5.) Solution: 1 pound to 5 gallons. Adult mites all killed. Molting mites apparently all dead in two days. Eggs evidently affected, not all killed, but many collapsed by the second day.

(6.) Solution: 1 pound to 1 gallon. (This solution is nearly solid when cold.) Mites all killed. On the second day all the eggs appeared collapsed and dead.

The whale-oil soap usually supplied by dealers is inferior to that used in the above experiments. As an effective remedy for Rust-mite a solution of 1 pound to 5 gallons of water may be recommended. It should be applied in early spring, before the new growth begins. Two or three applications will be required, which should be made at intervals of one week. The cost of the wash, at the ordinary retail price for the soap (10 cents per pound), is 2 cents per gallon.

Very weak solutions may be made effective if used at frequent short intervals, but the labor and expense of making the numerous applications required will be very great.

A solution of 1 pound to 5 gallons will not injure the trees, but may cause the blossoms to drop. No directions can be given as to the greatest strength of solution that can be used upon blooming trees without loss of fruit, as this depends largely upon the condition of the tree. Solutions of 1 pound to 10 gallons can probably be safely used, in most cases, and will be effective if several applications are made at intervals of a few days.

Sulphur.—The mites, both adult and young, are very sensitive to sulphur, and are readily killed by it in any form in which it can be made to act upon them. The eggs, however, are not readily affected, and even survive an exposure to the fumes, which will kill the plant. Fumigation cannot be resorted to without extreme danger to the life and health of the tree. The finely powdered (sublimed) flowers of sulphur does not affect the plant. It adheres more readily than might be supposed to the smooth surfaces of the leaves, and especially when they are roughened by the mites, it is not entirely washed away by heavy rains. Although it does not kill the eggs, it effectually exterminates the free mites, which are sure to come in contact with it in their wanderings, and if it can be made to remain upon the plant, the young as they hatch are also destroyed.

Flowers of sulphur must therefore be regarded as one of the cheapest and most effective remedies for Rust-mite, and it may be used to great advantage in connection with whale-oil soap or other insecticides. It may be suspended in water and applied in spray. With proper ap-

pliances the dry powder may be sifted or blown upon the foliage when wet with dew or rain. A little wheat-flour added to the powder would increase its adhesiveness.

The pharmaceutical preparation known as milk of sulphur (precipitated), although a much more finely divided powder, proves milder in its effect upon the mites, and its cost will prevent its extensive use.

EXPERIMENTS.

(1.) A small seedling orange infested with Rust-mite was covered with a nail-keg and fumigated for ten minutes by burning one ounce of sulphur under the keg. All the mites were destroyed, but the eggs remained alive ten days, and finally dried up with the leaves of the plant, which was entirely killed.

(2.) Flowers of sulphur dusted over infested leaves through a loosely woven cloth. Free mites all dead in twenty-four hours. Molting young all dead in three or four days. Eggs not killed in nine days, but young mites killed soon after hatching.

(3.) Experiment No. 2 repeated in the open air, and leaves allowed to remain on the tree. Heavy rains on the second day did not remove all the sulphur. Results the same as in No. 2. Mites all killed. Eggs not killed.

(4.) Milk of sulphur dusted upon the leaves through muslin. Effect less powerful than in Nos. 2 and 3, but mites in the end all killed. Eggs not killed.

(5.) Milk of sulphur; two ounces by measure, of the powder suspended in one gallon water. Leaves dipped in the liquid, when dry were lightly coated with grains of sulphur. Adult mites dead on the second day. Some molting mites and numerous eggs alive on the second day.

(6.) Leaf with mites confined in a tight box with another leaf on which sulphur had been dusted. No effect after twenty-four hours. On the third day, however, only one adult mite appeared to be alive. In six days all the mites were plainly killed. Eggs not killed.

This experiment was repeated with sulphur scattered in the bottom of the box, and precautions taken to prevent its contact with the mites. Results precisely the same as before.

Note.—By confinement in very tight metal boxes, mites may be kept alive between one and two weeks, or until the leaves dry up or mold. The destruction of the mites in this experiment was therefore due entirely to the slow volatilization of the sulphur.

(7.) Sulphuretted hydrogen. Leaves dipped in water strongly impregnated with the gas. In twenty-four hours all adult mites were dead or dying. In thirty-six hours all free mites were dead. In the same time 40 to 50 per cent. of the molting mites died. On the third day many molting mites remained alive. Eggs not killed.

The above solution of sulphuretted hydrogen (sulphur water) was prepared by passing through two gallons of water, the gas given off by three ounces of sulphuret of iron, treated with dilute sulphuric acid.

The remarkable results obtained with sulphur in these experiments, and especially the effect upon the adult mites of the gas in solution, suggests the use of water from the sulphur springs which abound in various parts of Florida. Although it cannot be supposed that these natural waters contain a sufficiently high percentage of the mineral to render them powerful insecticides, their value cannot be determined without trial. Persistent applications may suffice to ultimately exterminate the Rust-mite or cause its disappearance from the trees. In view of its

possible importance as a remedy, those who have access to natural springs or who now use flowing wells of sulphur water for the purpose of irrigation, should thoroughly test it by making repeated applications at short intervals.

Kerosene.—Emulsions containing 66 per cent. of kerosene oil, and diluted with water ten times, as in applications for scale-insects, do not kill the eggs of the Rust-mite. The same emulsions diluted one to twenty, kill nearly all the mites, but do not kill the eggs. With dilutions of one to forty, many adults escape destruction. In all the experiments made with kerosene upon scale-insect the trees were not cleared of Rust-mites. They usually reappeared in numbers, within five or six days, owing to the hatching of the eggs. As a remedy for Rust-mite, therefore, kerosene is not as effective as either whale-oil soap or sulphur.

In making applications for scale-insect it is advisable to render the wash effective against Rust-mite also, and this can be in a measure ac-accomplished by adding sulphur.

Experience has shown whale-oil soap to be superior to condensed milk in forming emulsions, and much cheaper. Emulsions made with soap do not thicken or ferment, as when milk is used.

The formula that has already been published (see ante, page 331) gives the best results.

The emulsion should be diluted with water ten times, or in the proportions 1 to 9, and applied in fine spray.

In cases where an application is needed for both scale-insect and Rust-mite the above wash, with two or three ounces of sulphur added to each gallon of the mixture, forms the most effective combination that can at present be devised. It is best applied in early spring, but should never be used in midwinter or when there is danger from frost.

Creosote.—Several experiments with crude oil of creosote, saponified with lard oil and lye, or dissolved in strongly alkaline solutions, gave about the same results as 66 per cent. kerosene emulsions. The mites were readily killed, but their eggs for the most part survived.

Creosote is highly poisonous to plants, and must be used in small doses. Four or five fluid ounces of crude oil of creosote, dissolved in one gallon of strong soap solution, makes as strong a wash as it is safe to apply. Although even cheaper than kerosene, it is not a more effective remedy, and, owing to the greater danger attending its use, it cannot be recommended in preference to the latter.

A strong carbolic or creosote soap can be purchased at a reasonable price, and will prove very useful to orange-growers, as it is not only a powerful insecticide, but also a remedy for "die-back," and possibly also for "foot-rot," or any disease of the plant of fungoid origin.

Potash.—Very strong lye is required to kill the mites, and their eggs are not destroyed except by solutions sufficiently caustic to burn the leaves and bark.

The different commercial brands of concentrated lye and caustic potash vary greatly in purity and strength. The potash used in the following experiments was a superior article, put up in 1-pound balls, coated with rosin:

(1.) Solution: 4 pounds (48 ounces) potash to 1 gallon water. Leaves dipped in this solution were badly burned, and, together with them, the mites and eggs were entirely destroyed.

(2.) Solution: 2 pounds (24 ounces) potash to 1 gallon water. Leaves charred. Mites and eggs destroyed.

(3.) Solution: 1 pound (12 ounces) potash to 1 gallon water. Mites nearly all killed. A single living adult seen. Molting mites and eggs not all killed. Leaves devitalized, but not charred.

(4.) Solution: 8 ounces potash to 1 gallon. Adult mites nearly all killed. One half-grown mite seen crawling about among crystals of potash. Molting mites and eggs not killed.

(5.) Solution: 6 ounces potash to 1 gallon. Adult mites killed. Several recently molted mites seen crawling on second day. Molting mites not killed. Eggs uninjured.

(6.) Solution: 4 ounces potash to 1 gallon. Many adult mites killed; some alive. Numerous young mites alive on second day. Molting mites and eggs uninjured.

(7.) Solution: 3 ounces potash to one gallon. Same results as No. 6.

Solutions of 1 pound to the gallon have been used upon orange trees, and although all the leaves and portions of the bark were destroyed, they recovered rapidly from the effects of the application. Such heroic treatment for insect pests is, however, unnecessary and unadvisable.

Pyrethrum.—Applied in fine powder, this insecticide visibly affected the adult mites and caused them to erect themselves frequently upon their anal prolegs. The free mites left the leaves in a few hours, but it is doubtful if many of them were killed. The molting mites and eggs remained uninjured. Continued exposure to contact with the strong powder disables and finally kills the mites, but they are not as violently affected as many of the higher insects, and recover from slight applications.

Lime.—Not the slightest effect was obtained with applications of lime, as the following experiments will show:

(1.) Freshly air-slaked stone-lime dusted thickly over infested leaves. Mites continued feeding and propagating under the coating of lime-powder, and did not abandon the leaves during eight days in which they were kept under observation.

(2.) Slaked lime: 1 pint measure suspended in 1 quart water, and allowed to partly settle. Leaves dipped in the turbid liquid. No injurious effect upon the mites or their eggs. Adult mites were rendered restless by fine particles of lime adhering to them, and all left the leaves within two days, but were not killed.

(3.) Same solution as No. 2, clarified by standing several days. Leaves dipped in the clear lime-water. No effect whatever during eight days' observation.

Ashes.—Finely-sifted hard-wood ashes dusted upon the leaves produced no effect whatever upon the mites, and did not seem to discommode them in the least.

The above experiments were made in December during continued cold weather, which retarded the development of the mites and interfered somewhat with observations as to hatching of the eggs under treatment.

CAUTION.

There is danger in applying penetrating liquids to orange trees during the winter. First, because any shock to a dormant tree is apt to start the buds and induce new growth, at a time when there is danger of frost. Secondly, a succession of cold nights and cloudy days, such as frequently occurs in severe winters, following immediately after an application, will increase to an injurious extent its effect upon the plant, by preventing evaporation of the liquids used and allowing them to remain too long in contact with the leaves and bark. Serious loss is liable to follow a disregard of this warning.

SECOND REPORT ON THE CAUSES OF THE DESTRUCTION OF THE EVERGREEN AND OTHER FOREST TREES IN NORTHERN NEW ENGLAND AND NEW YORK.

By Dr. A. S. PACKARD, *Special Agent*.

In pursuance of the work of the last season, I visited the Adirondack region of New York in June and July of the present season, and then made an extended journey through Aroostook County, Maine, visiting the Moosehead Lake region, and spent the remainder of the summer at Brunswick, Me., and on the shores of Casco Bay. My object in visiting Northern New York and Maine in the latter part of June and early in July was to ascertain whether the Spruce-bud Tortrix described in my last report was concerned in the widespread destruction of spruce and fir in those important lumbering regions. The result showed that this caterpillar, which has in former years been so destructive to the spruce and fir in Cumberland and adjoining counties, has not been at work to any appreciable extent in the northern forests. Indeed, not a caterpillar of this species (*Tortrix fumiferana*) was to be found after diligent search in the Adirondacks nor in Aroostook, and at Moosehead Lake but a single specimen was captured, early in July (the 7th), showing that it was much less common this year than at the Rangely Lakes last season. Here it may be remarked that the same caterpillar was found late in June (the 22d) to be less common about the shores of Casco Bay than in 1883. This shows that this destructive insect is gradually becoming scarce.

THE DESTRUCTION OF SPRUCES IN NORTHERN NEW YORK.

I spent about two weeks in the middle part of June in the Adirondacks, passing through the more mountainous portions, from the Ausable Chasm to Scroon Lake, spending most of the time at Keene Flats, at Beede's Hotel, in the heart of the forest region. Mr. Beede, who was formerly a lumberman and guide through these forests, informed me that the spruce had been dying for the past fifteen years, and that on the mountains surrounding the hotel about one spruce in ten had died; and from our observations and those of George Hunt, esq., of Providence, who kindly accompanied me on this journey and who has visited these woods for many years past, we should judge this to be a moderate estimate. The trees had not died in masses or clumps, but simply individually, and in places only were the dead trees especially thick. That they had not died from the attacks of caterpillars was also evident from the appearance of the trees, particularly the terminal branches, which showed no traces of having been eaten back by worms, such as is the case on the coast of Maine; moreover, no traces of the bud-worms were to be found either on the young trees bordering open fields or roadways or in the forests.

Mr. Beede, like others, attributed the death of these to drought, but it was observed that the trees were dying in damp, protected places, as well as in situations where severe drought might injuriously affect them, and that the pines and maples, as well as other trees, were in a healthy condition. The path up to the summit of the "Giant of the Valley" led through spruce woods, in which there were numerous dead and dying spruces. None or scarcely any dead spruces or firs were observed which did not have the bark filled with bark-borers, species of *Dendroctonus* and *Tomicus*, or allied genera.

Two large living spruces, the wood full of sap and the leaves fresh and green, were examined, and in the bark were numerous beetles of the genus Hylurgops, both in the worm or grub state and in the beetle stage. These beetles, while in the young or worm condition, run their galleries into the sap-wood and partially girdle the tree. There were enough worms in these trees to ultimately kill them, and there was no doubt but that these two trees were doomed to death by this cause. We mention these cases especially, as it is doubted by some entomologists in Europe whether living, healthy trees are attacked by borers. Our experience teaches us that not only spruces, firs, and pines are attacked and killed by boring beetles, but the experience of others, notably that of Dr. C. Hart Merriam, shows that entire groves of sugar-maple saplings in Northern New York have been killed outright by a little bark-borer. His account is published in full in the *American Naturalist* for January, 1883, p. 84. The following extract will show the nature of the attack and the result to healthy, living trees:

> About the 1st of last August (1882) I noticed that a large percentage of the undergrowth of the sugar-maple in Lewis County, Northeastern New York, seemed to be dying. The leaves drooped and withered, and finally shriveled and dried, but still clung to the branches. The majority of the plants affected were bushes a centimeter or two in thickness, and averaging from one to two meters in height, though a few exceeded these dimensions. On attempting to pull them up they uniformly, and almost without exception, broke off at the level of the ground, leaving the root undisturbed. A glance at the broken end sufficed to reveal the mystery, for it was perforated, both vertically and horizontally, by the tubular excavations of a little Scolytid beetle which, in most instances, was found still engaged in his work of destruction.
> At this time the wood immediately above the part actually invaded by the insect was still sound, but in a couple of months it was generally found to be rotten. During September and October I dug up and examined a large number of apparently healthy young maples of about the size of those already mentioned, and was somewhat surprised to discover that fully 10 per cent. of them were infested with the same beetles, though the excavations had not as yet been sufficiently extensive to affect the outward appearance of the bush. They must all die during the coming winter, and next spring will show that in Lewis County alone hundreds of thousands of young sugar-maples perished from the ravages of this Scolytid during the summer of 1882.

As has been stated in our Bulletin on Forest-tree Insects, it is well known that healthy, large sugar-maples are often attacked and killed outright by the borer which attacks that valuable shade tree. The instances of the death of healthy trees of various kinds from the attacks of internal pests or of bark-boring beetles are so numerous that we are now inclined to believe that the death of the spruces in Northern New York and New England is almost wholly due to this cause. It is the belief among some lumbermen that the spruces are dying of old age. There is undoubtedly a natural limit to the life of any tree, but why should this cause have been confined to the spruce only within the last ten or fifteen years? Spruces, like other trees, have died of old age since the world began! Again, summer droughts and winter storms and severe cold weather should not affect the spruce more than any other tree of our forests, especially the pine and the hemlock. On the contrary, the spruce is our hardiest tree. It lives farthest up on mountain summits; it is the northernmost of our evergreen trees, living nearer the Arctic circle than even the larch. It can withstand severe drought, flourishing on rocky ground where the soil is thinnest; it grows luxuriantly in swamps where the ground remains frozen later than elsewhere, and the arrangement of its branches enables it to withstand heavy snows and winter storms as well, if not much better, than any other tree of our northern forests. The adverse forces of nature, winds, gales, frost, snow, sudden heat, and drought have acted for ages upon the

spruce, and by the processes of natural selection the weak qualities of other evergreen trees have apparently been eliminated from it; it has survived and persisted by reason of its unusual powers of endurance, its toughness, and insensibility to the rigors of a northern and subarctic climate. It has, however, of late years, and perhaps periodically, been the special prey of boring insects, species which also attack its allies and the pines, but which seem in regions from which the pine has been eliminated by the ax of the lumberman to concentrate their forces on this tree.

THE DESTRUCTION OF SPRUCES IN NORTHERN MAINE.

Passing into Aroostook County by railroad by way of New Brunswick, we learned that the spruces were still dying in portions of that Province in great numbers. For example, we were told that Mr. Gibson, of Fredericton, in the winter of 1882–'83 sent parties up the Nashwaka River, a branch of the Saint John, with the expectation of cutting 40,000,000 feet of spruce lumber; but half of it was found to be dead. An examination of the spruces in the vicinity of Presque Isle, Ashland, and Patten showed that the bud-worm had not been at work in those parts of Aroostook, nor along the road from Patten to Mattawamkeag.

In townships 8 and 9 (range 7 or 8?), on the headwaters of the Saint Croix and Mattawamkeag, I was informed by a lumberman of unusual powers of close observation that the spruce trees had only been affected during the past five years. When he first went into the woods he found the trees dying, and then advised the owners to fell them; this was the best possible advice, but it was not taken. He said the trees would make good lumber for the second year after they showed signs of dying, as it takes two years for them to become wholly dead. He estimated that over the region he lumbered in about one in eight trees had died; in some localities two-thirds had been killed. He was the only lumberman we have met who unhesitatingly attributed the disease to borers, though we have been told by heavy owners of lumbering regions that the borers were the cause of the disease. This man repeatedly removed the bark, and, as he said, "found it full of little white worms." He also assured me that he found similar worms in *living* spruce trees, and that the result of their work was to girdle the tree.

From conversations with different lumbermen it appears that a spruce tree a foot in diameter gets its growth in from forty to fifty years. The larger trees can be culled out of the same lumbering region every ten years. Lumbermen have the impression that a spruce tree grows rapidly. This of course depends on the soil, position, and climate. We have found the past season that spruce saplings about 4 feet high get their growth in three years; it is easy to ascertain this by the difference in the color and appearance of the bark. Whether the spruce grows more rapidly than hard-wood trees remains to be ascertained. Standing in a yard of a house in Maine, a sugar-maple, which has been a rapid grower, and which we know to be about forty-eight years old, measured, in September, 1884, 1 foot from the ground, 2 feet $\frac{2}{3}$ of an inch in diameter. The Thorndike oak, on the campus of Bowdoin College, raised from an acorn planted on the first commencement day of the college, on the first Wednesday of September, 1806, now measures, at 1 foot from the ground, 30 inches in diameter, having therefore attained its present dimensions in seventy-eight years.

From Mattawamkeag we went to Moosehead Lake. Throughout the great range of forests to be seen from the lake at and south of Mount Kineo no dead spruces were to be observed; though a single bud-worm

(*Tortrix fumiferana*) was beaten from a young spruce July 6. Here, however, as everywhere else, dead spruces occasionally occurred whose bark was filled with Scolytid beetles.

From E. S. Coe, esq., of Bangor, to whom we are indebted for information regarding the destruction of spruce timber in Maine, we learned that large tracts of spruce timber near Kennebagó Lake, on the height of land between the Androscoggin and Forks of the Kennebec, had been destroyed.

Mr. Coe also informed us that he learned from General Smith, of Norridgewock, that the spruce growth about that town and Waterville early in this century had been diseased, and died very much as in the past few years.

From various persons we learned that the evil is now abating, and without doubt if the tracts of dead spruce could, at least those near settlements or villages, be cut down and removed, leaving, however, the spruce undergrowth, a new growth of spruce would spring up, which in forty or fifty years could be profitably lumbered.

CONDITION OF THE HACKMATACK IN 1884.

The larches, or hackmatacks, throughout the region passed through the past summer have been examined with a good deal of interest in order to note the effects produced by the ravages of the larch-worm (*Nematus erichsonii*) during the two preceding summers. In our last report we gave the history and degree of ravages caused by this worm.

The hackmatack, or larch, is a very hardy tree, only less so than the spruce, as it grows near the northern limit of trees and is commonly associated with the spruce on the bleak, almost treeless, coast of Northern Labrador, where we have seen it in abundance, though dwarfed compared with the size it attains in Northern Maine and New Brunswick.

As the worm does not appear until early in July, it had not of course begun its work at the time we were in Northern New York. Throughout Northern Maine this saw-fly was rarely seen. At Woodstock, New Brunswick, the freshly-hatched worms were detected about the 1st of July, but the larches observed along the road from Presque Isle to Ashland and Patten were but slightly affected. The flies were scarce, a great falling off in numbers from the previous years, and the trees during the first week of July were but slightly affected. When the worms have attained a considerable size, and have been destructive to the leaves, the trees begin to turn brown and to present a very characteristic appearance, as if a light fire had passed through them. Only at a point along the railroad south of Dover, Me., were a few larches seen which had turned somewhat brown, and there were a few slightly brown trees seen from the cars between Bangor and Augusta. Later in the season, in August, after the worms had disappeared at Brunswick, the larches were found to have been but slightly harmed by the few worms hatched out this summer.

On the whole, then, while a small proportion of larches have been killed by this worm, this vigorous tree, though defoliated for two successive summers, seems in the majority of cases to survive the loss of its leaves, though it threw out much shorter ones the present summer. Possibly 10 per cent. of our northern larches died from the attacks of this worm. Very probably the numbers of this insect will diminish during the next year, and the species may ultimately become as rare as it has always been in Europe, until a decrease in its natural insect parasites, and favorable climatic causes induce its undue multiplication.

THE REDDISH-YELLOW SPRUCE-BUD WORM.

(*Steganoptycha ratzeburgiana* Sax.)

A caterpillar not before observed by us was found to be very injurious to the white spruce, and in a less degree the black spruce on Squirrel Island, Booth Bay Harbor, Maine. July 11 the white spruce shoots particularly were found to have, in many cases, been stripped bare of their leaves, especially the terminal fresh shoots. The shoots had been stripped either wholly or only on one side, some of the young trees being badly injured, and as they were used as ornamental shrubs around the summer cottages on that island, their beauty was seriously marred. They also affected the white-spruce trees growing wild among the rocks on the shore, while but a few black spruces had been injured. The shoots and branches were fairly alive with the moths, which, on being disturbed would rise up in great numbers and then settle down upon the leaves. Upon sending a specimen to Prof. C. H. Fernald, of the Maine State College, who is the leading authority on the *Tortricidæ*, a family of leaf-rolling moths, he kindly informs me that it is a new depredator, only recently detected in this country. His letter to me reads as follows:

MAINE STATE COLLEGE,
DEPARTMENT OF NATURAL HISTORY,
Orono, Me., October 4, 1884.

MY DEAR PROFESSOR: Your card and the insect have come to hand. I have taken this insect at Mount Desert in the latter part of July, 1882, in abundance around spruces in which the terminal twigs were destroyed. This was presumptive—though not positive—evidence that they were the ones that caused the destruction of the twigs. I found them again this summer, early in July, on Islesborough, around spruces in the same way as described above. I have also received the insect for determination from New Hampshire. This, I believe, is the entire history of the insect in this country, for it has never been sent to me except as above, and it is not in any of the collections of the country to my knowledge.

I at once determined it to be a *Steganoptycha*, and as it agreed with nothing in my American collection, I turned to the foreign species and found that it was near, if not identical with, the European *S. ratzeburgiana* Sax. I have three examples from Germany which vary somewhat, as do the specimens of this country. I have now given them a critical examination and comparison, and believe them to be identical. I made a microscopical examination of the genitalia of the males, and find them alike. So far as any studies which can be made on the imagos go they would be regarded identical.

If you found the larvæ and made any studies on them, I would be glad to have you compare them with what the following authors say, and let me know whether they agree or whether the early stages differ. See the following works, which I think comprise the entire history of the literature of the subject: Ratzeburg, Forest Insects, vol. I, p. 227, plate 12; fig. 3, Imago; 3 L., larva; and plate 13, figs. 3 and 4, twigs destroyed by the larvæ: Zeller, Isis (not in my library), 1846, 242: Herrich-Schaeffer, Schmetterlinge von Europa, vol. V, p. 208: Heinemann, Wickler, p. 212, who states that the larvæ live in spring in the young shoots of *Pinus abies*. Duponchel describes it on page 568, and gives a fair figure on Plate 266 under the name *tenerana*, mistaking it for Hübner's *tenerana*, which belongs to another genus. Stainton's Manual, vol. 2, p. 238, under *tenerana*, says, "not scarce among fir trees." Wilkinson, British Tortrices, p. 186, under *tenerana*; Freyer (not in my library); Guenée, Index methodicus, 26, under the name *errana*: Westwood, British Moths (not in my library), *pinetana*; Kaltenbach, Die Pflanzenfeinde, p. 698—you may get some help from this; Frey, Die Lepidopteren der Schweiz, p. 325.

Yours, truly,

C. H. FERNALD.

DR. A. S. PACKARD.

Like the dark olive-brown bud-worm (*Tortrix fumiferana*) this worm eats around the bud in June, gnawing off the leaves and thus loosening them, so that they remain attached by a loose, slight web filled with

the castings, and under this mass the caterpillar lives concealed from the prying gaze of insectivorous birds.

As it was late for the caterpillars, nearly or quite all having transformed into moths, only a single belated worm was found, which, there is the strongest presumptive evidence for believing is the young of the moth in question. It is much smaller, nearly one-half as large, and entirely different from the caterpillar of the common spruce bud-worm (*Tortrix fumiferana*) and is of a general reddish-yellowish hue.

The body is flattened, the head of a deep reddish honey-yellow, while the body is pale rust-red, with a darker dorsal stripe and a paler band on each side. The piliferous warts are paler than the ground color. The body low down on the sides and beneath is yellowish. All the legs, both thoracic and abdominal, are pale honey-yellow. Length, 7^{mm}.

Without doubt the caterpillar hibernates when nearly full grown, attacks the shoots in June when the new leaves are growing out, and goes into the chrysalis state by the end of the month, the moths appearing during the first and second weeks of July. Of course it is desirable that the caterpillar be reared, so as to leave no doubt as to its identity with the moth in question.

When the young trees and shrubs are found to be affected, they should be sprayed with Paris green or London purple in solution.

THE COMMON LONGICORN PINE-BORER.

(*Monohammus confusor* Kirby.)

[Plate V, Fig. 3; Plate VI, Fig. 1; Plate VII, Fig. 1.]

Although this borer is destructive to the white pine, I have not yet met with an instance where a living pine tree has been killed outright by it. In Maine, however, wherever the fir abounds, this insect is very destructive. While the fir is the least valuable of our timber trees, it is a beautiful shade and ornamental tree, though short-lived. It is especially liable to attack from this borer. In passing along any road in Cumberland County, particularly near the sea-coast, and also on the islands in Casco Bay, great numbers of dead firs are to be seen perforated with the round holes, large enough to admit a lead pencil, made by this borer for the exit of the beetle.

I have already given instances in Bulletin 7, United States Entomological Commission, pp. 220, 236, of living fir trees killed by this borer. During the past summer I have observed several, at least four or five, living firs in which these borers were at work. The trees were either wholly fresh and alive or some of the branches were dead, as well as a part of the bark on one side. A large number of fully grown worms were taken out of a fir on Frenchman's Island, which was dead on one side, the other half of the tree being alive, and the leaves all fresh and green. There seems no reasonable doubt but that this tree, then, is attacked while in a perfectly healthy state by this borer, and killed after one or two years.

How thoroughly one or two females of this beetle may stock a single tree with young borers may be seen by reading the following account of observations made by us the past summer. It should be stated in this connection that we have been told by an intelligent lumberman near Rangely Lake, Maine, that large masses of living firs in that region have been killed outright by the borer, which is undoubtedly this spe-

cies of beetle. The insect is figured in all its stages in our Bulletin, and the beetle in Harris's Treatise on Insects, and in other publications. It is a member of the family of long-horned beetles; its antennæ or feelers being about twice as long as the body. Its body is nearly as thick as one's little finger, and it is of a mottled gray color, marbled with white and dark-brown irregular patches. Thus marked it is, while resting on the bark of a moss-grown and lichen-covered fir, spruce, or pine tree, protected from the observation of birds, its colors being so assimilated to those of the bark of either of those trees that it readily escapes observation. The beetle appears early in June, and is to be found through the summer until early in September; and at any time in July and August, as well as the first week in September, it lays its eggs in the manner to be described.

Professor Riley has described in detail in the *New York Weekly Tribune*, February 20, 1878, the mode of oviposition of the Round-headed Apple-tree borer (*Saperda bivittata*), and his account has since been confirmed in the *Rural New-Yorker* for January 12, 1884, by Mr. C. G. Atkins. The beetle makes a straight slit in the bark.

The exact mode of the deposition of their eggs by the Longicorn beetles is imperfectly known so far as we are aware. Perris, in his *Insectes du Pin Maritime*, describes the mode of oviposition of *Ergates faber* and *Criocephalus rusticus*, but not of *Monohammus*. We have been fortunate enough to observe the female beetle while at work making the incision with her jaws, though we have not observed the final act itself of deposition of the eggs. While examining the fir trees on the western shore of Birch Island, Casco Bay, Maine, on a warm, sunny afternoon of August 30, I saw a male *Monohammus confusor* standing on the bark of a living fir about 9 inches in diameter, within the distance of 2 inches from a female, whose jaws were buried in the bark of the tree on the western side of the trunk, which was exposed to the full rays of the sun.

On beginning to make the incision, each of the large, sharp, strong jaws of this beetle is pushed directly into the bark; they are then apparently brought together, and the result is a slight curvilinear gash which descends obliquely in the bark. It is probable that the beetle pries up the pad thus formed, so that the freshly-cut edges are exposed, and an opening is thus formed into which the egg is thrust. While watching the female at work the male dropped to the ground, and his consort becoming alarmed withdrew her jaws from the incomplete incision, when I seized her. To the end of her abdomen were attached a few fragments of the reddish bark of the fir, and two or three small green pellets, probably excrement; but this showed that she had already deposited at least one egg, and that the labor was slight, the end of the abdomen probably being simply extended and thrust into the gap of the incision. The Longicorns, like most other beetles, have no true ovipositor, but the end of the abdomen is a simple, flattened, horny tube, in which the oviduct terminates; the end of this sheath or tube is probably thrust into the gash made by the jaws.

By prying up the pad formed by the jaws a shallow but roomy cell or chamber is made for the egg, which lies nearly or quite horizontally, not vertically.

The egg (Pl. V, Fig. 3, *a*) is very large, ovo-cylindrical, well-rounded, but tapering somewhat at each end, of a dirty-white color, and in length is $4\frac{1}{2}^{mm}$.

On visiting the tree a week later and removing a portion of the bark

and examining it, September 6–8, the eggs had in some cases hatched and the larvæ had begun to descend slightly into the bark. On hatching they begin at once to gnaw a mine, throwing their castings out through the gash originally made by the female, so that it was easy to ascertain without disturbing the bark whether the eggs had hatched or not. The larvæ indifferently lie with either side, dorsal or ventral, presented outwards. Three days after (September 12) several had bored through the pieces of bark, making the usual flattened oval hole, but probably in nature the larva remains hidden in the bark through the winter, not beginning to penetrate the wood until the following spring.

The length of the larva when freshly hatched was 5–6^{mm}, and the body was rather stouter than in the fully-grown larva. (Plate V, Fig. 3, *b*.)

How many eggs are laid by the female is not known, but, probably, judging by their large size, comparatively few.

Another female was found on the same tree. Over a hundred gashes had been made on the western side of this fir tree over a space 4 feet long; the gashes were so fresh that they must have been made on that and the previous days. They were quite conspicuous, and could, after one had become familiar with their appearance, be detected at the distance of 5 or 6 feet from the tree. I suspect that the sexes couple frequently during the operation of egg-laying, as the male was standing so near his mate with his antennæ outstretched and intently watching the female while at work. The males are also probably polygamous.

The industry of the female is well shown by the number of gashes made (Plate VI, Fig. 1, *a*, *b*), some of which did not, however, contain any eggs. In the space of a square inch there were three gashes, while in the region where they were thickest forty were counted in half a square foot. Of course when they hatch all do not live to pass through their transformation. Whether the woodpeckers seek for and discover the larvæ ensconced in the bark is doubtful, and yet it would be easy for them or other birds to pick the grubs out of their hiding-places. So far as my observations have gone the holes made by the woodpeckers in forest trees are for the purpose of getting at the inner bark rather than for insects. But a careful examination of woodpeckers shot in coniferous forests would throw light on this subject.

In regions where the white pine grows it is infested by the Monohammus. The spruce is also often infested, but I have not seen clear cases where either of those trees have been killed outright by this destructive borer. But during the past summer I have seen on the islands in Casco Bay and taken out the full grown larvæ from at least six or seven living firs, which must have been killed by the attack of this borer, which has been the evident cause of the death of many firs in Maine.

I have seen hundreds, perhaps nearly a thousand, dead firs whose trunks were riddled with the holes of these borers. The spruce is less frequently killed, but I have taken from a dead tree two pieces of spruce bark, each about 6 inches square, one containing sixteen and the other eighteen holes through which the beetle had escaped. Pl. VII, Fig. 1, represents one of these specimens of natural size.

THE SUGAR-MAPLE BORER.

(*Glycobius speciosus*, Say.)

This destructive borer, which has been described and figured in Bulletin on Forest Insects, is still at work in Maine, where we made such observations on its egg-laying habits and the mode of l a the freshly-hatched larva, that it now seems possible to prev its entry into the heart-wood by cutting it out of the bark in the autu

The burrows, or mines, either extend under the bark or descend into the wood towards the heart of the tree. Different trees are variously attacked. Where the worms remain under the bark large pieces are loosened and gradually fall off, leaving sometimes nearly one side of the trunk bare. At the same time the general health of the tree is impaired, as shown by the sparseness of the leaves.

The beetles were unusually frequent in Brunswick during late July and especially in August, and at this time lay their eggs. Although none were found engaged in the operation, there is little doubt, as will be seen below, that the process is nearly identical with that of the pine-borer, or Monohammus. I found two mines of this borer which crossed each other, though usually each follows an independent course, unless much crowded. On a single tree from one side of which the bark had fallen off in consequence of the attacks of this insect, there were about twelve "mines," or burrows, of which ten ran up the trunk. The mines were from 15 to 24 inches long, one measuring 2 feet and 8 inches in length. At the upper end the mines are about ⅜ inch wide. The mine either finally sinks deep in the wood or extends all the way under the bark until at the extreme end, where it sinks in a little way to form a cell, or chamber, for the chrysalis.

The trees die slowly, and where the trunk has been mined on one side only the tree lives on, though the foliage be much thinner. Trees may, as we have observed, live for at least five or six years with a number of borers in their trunks.

Fresh from the observations made on the mode of egg-laying in the common pine-borer, I looked, September 12, for the eggs or freshly-hatched larvæ of *Glycobius speciosus*, and found the latter at once. The Rev. Mr. Leonard, of Dublin, N. H., many years ago, in a letter to Dr. Harris, stated that the maple-tree borer, on hatching, remained in the bark through the winter. Upon examining a sugar maple about 2 feet in diameter, it was found that twenty eggs had been laid in different parts of the bark from near the ground to where the branches originated, a distance of about 10 feet. The site of oviposition was recognized by a rusty, irregular discoloration of the bark about the size of a cent, and especially by the "frass," or castings, which to the length of an inch or more were attached like a broken corkscrew to the bark. On cutting into the bark, the recently-hatched larvæ (5–7^{mm} in length) were found lying in their mines, or burrows, at the depth of a tenth to the sixth of an inch.

The burrows already made were about an inch long, some a little longer; the larva usually mines upward. No eggs were found, but they are laid in obscurely marked gashes, about a fifth of an inch long, usually near a crevice in the bark.

These gashes and castings are readily discoverable, and it would be easy to save these valuable shade trees by looking for them in the autumn and winter or early spring and cutting out the worms. The bee-

tles were not uncommon at Brunswick in July and August the past year. Of six grubs which I cut out over half seemed unhealthy, perhaps diseased by the water which had penetrated their mines.

I have recommended protecting valuable shade trees by wrapping the trunks with bands of cloth well saturated with kerosene oil in August and September, so as to drive off the beetles and to destroy the freshly-hatched grubs, but since discovering how easily the grubs and castings of the freshly-hatched worms can be detected a few days or weeks after the eggs have been laid, it seems obvious that the easiest and surest preventive is to cut out the grubs when lying in their autumn and winter quarters just under the surface of the bark. It is almost impossible to destroy the fully-grown worms in their "mines" or burrows, since the latter extend up the tree either directly under the bark or are sunken in the wood. On one tree nearly destroyed by this borer, out of about fourteen mines twelve extended upward. Hence it is useless to try to find the hole and inject oil into it. There now seems no reason why valuable shade maple trees should not be saved by a few hours' close observation and removal of the young grubs, say in September or October.

THE POPLAR-BORER.

(*Saperda calcarata* Say.)

This borer has been destructive to poplar trees on the shores of Casco Bay, especially at the head of the bay west of Harpswell Neck, where my attention was first called to its work by ex-Governor J. L. Chamberlain, on whose estate at New Wharf a number of trees had died. The trees in August are seen to show unmistakable signs of disease by the leaves curling and withering. The presence of the larva within is easily detected by the masses of castings resembling sawdust, which are thrown out of the holes and falls down the trunk to the ground.

Upon cutting down the trees and splitting them open, not only the fully-grown larva, or grub, but also one or two pupæ and several beetles were found, the latter ready to issue from their holes. As many as eight or ten larvæ were found mining in a portion of a poplar trunk 10 inches long and 5 inches in diameter.

The wood was perforated in all directions, running under the bark part of the way and sinking in various directions into the wood, some of them extending side by side along the heart of the tree. The longer mines are about a foot in length, and about a centimeter, or four-tenths of, and at times half, an inch in diameter. Part of the mine is more or less stuffed with long, slender chips gnawed off by the larva.

The worm and beetle have been already described and figured in Bulletin 7 of the United States Entomological Commission, p. 118.

INSECTS AFFECTING FALL WHEAT.

By F. M. WEBSTER, *Special Agent.*

THE WHEAT-STRAW ISOSOMA.

(*Isosoma tritici* Riley.)

On the 8th of May, in a field of fall wheat near Bloomington, Ill., which had produced a crop of the same cereal the previous season, I captured two wingless females of this species, which were placed in alcohol.

This was the first time the insect had been observed in this locality, being far north of any section of the State previously known to have been infested. Du Quoin, in fact, was about its supposed northern limit.

On the following day, in the same field, two additional apterous females were found.

These were at once taken home, and also a quantity of the growing grain, which was transplanted to a flower-pot. My insects were placed on the grain and covered with a large glass, through which I could observe all that transpired within. During the first day of their confinement they appeared to be wholly engaged in attempting to escape, and it was not until the evening of the second day, the 11th, that I noticed any disposition to oviposit.

On this evening both females had been observed for a couple of hours continually running up and down the wheat-plants. Suddenly one of them stopped, and, pushing herself as far away from the straw as possible, by throwing her legs directly beneath her and straightening them out, threw the abdomen forward and beneath her body, and as it recoiled toward its normal position the point of the ovipositor caught in the straw and opened from the groove along the abdomen, much as the blade of a pocket-knife half opens from the handle. Then, by drawing the straw toward her, and bracing the ovipositor with the abdomen to keep it straight, she was enabled to force its entire length into the plant, her body being now flat on the surface, the legs in the same position as when at rest.

To recover the ovipositor she placed her feet against the plant, pushing it from her until the body assumed nearly the same arched position as at first. When withdrawn the ovipositor at once sprung back to its place in the abdominal groove. These movements occupied from one and a half to two minutes, provided no difficulty was encountered in withdrawing the ovipositor.

This, however, was not always the case, as on one occasion, which came under my notice, twenty minutes were consumed in the recovery alone.

It is probable that the eggs are deposited singly, as I noticed that the female at once began the task of again puncturing the straw at a little distance away. On the next morning the second female was observed to oviposit, and both were very busily engaged during that and the following day. But in the evening I noticed they were less active, seeming much fatigued, and the work being accomplished with greater effort, so that I was little surprised on the next morning, the 14th, to find them both dead about the plants.

The ovaries of one were examined and found to be free of eggs, showing that she had finished her work.

During this time the fields had been searched assiduously for others, and I continued to do so without success until the 16th, when another female was captured in the same field where the others had been obtained, and, like them, wingless.

She was placed in alcohol and soon after dissected, and the ovaries found to contain a number of eggs.

I then began, by the aid of a microscope, a thorough examination of the tissue of the straw in which my confined females had oviposited, and, although I spent many hours in the search, and more than once felt sure I had found the eggs, was at last obliged to give up in despair, not wishing to sacrifice more of my supply of now precious plants.

The egg, as found in the ovaries, may be described as follows: Color white. Form gourd-shaped, the globular part measuring 0.21^{mm} in length and 0.14^{mm} broad; the stem 0.35^{mm} long and 0.04^{mm} broad, the entire length being 0.56^{mm}.

This was the last wingless female I was able to secure, although the search was continued during the entire month. On May 28 two of the potted wheat-plants were examined, and to my surprise each contained a two-thirds-grown larva in the space below the upper internode. A careful search failed to reveal any larvæ that could have emanated from the eggs deposited in the plants two weeks previous.

On the 1st of June, however, I found a minute larva on the inside of the single potted plant examined.

As it became necessary for me to leave Illinois at once and locate elsewhere, all observations in this field were necessarily put at an end. The remainder of my potted plants were taken with me, and on reaching my destination were placed in a newly-constructed breeding-cage.

From one of these plants, on June 7, I took a small larva, and on the 20th a wingless female appeared in the cage, and on the 23d I took a second adult from another plant. This last was also a female, but with aborted wings, and had died before making her way out of the straw.

It seems hardly probable that either of these adults or the larvæ found in the plants on May 28 could have developed from eggs deposited by females which had passed the previous winter in last year's stubble or straw, as the spring of the present year was cold and backward. It is more probable that they wintered in the new wheat as larvæ, the eggs having been deposited the previous autumn, which was exceptionally mild until quite late in the season, thereby maturing females which would otherwise have passed the winter as pupæ. Since coming to Indiana, the 4th of June, but two adults of the common form have come under my observation. One of these was captured in a field of timothy on June 12. The other was bred July 21 from wheat straw removed from the field on the 18th. Both of these possessed well-developed wings.

In all fields of wheat or rye examined in the vicinity of Bloomington and Normal, Ill., I found in considerable numbers a form of *Isosoma* much larger, possessing fully developed wings, and in several minor features differing from the common form of *tritici*.*

On May 29, while searching for larvæ in growing wheat in the field from which my potted plants were taken, I noticed a plant the upper and younger leaves of which were dead and discolored, as if some insect had been at work in the upper portion of the stem.

On examination I found just below the affected part a pupa, which unquestionably belonged to this larger form of *Isosoma*. There was, moreover, ample proof that the larva had previously inhabited the same quarters.

On the 31st I noticed that one of my potted plants began to show some peculiarities of growth, while there was no indication of forming any head. There was an abnormal gall-like development of the sheath where the head should have appeared. On opening this a larva, much too large to belong to the ordinary form of *tritici*, was found within, having evidently subsisted in and about the upper joint.

I visited the field again before leaving for Indiana, but could obtain no additional larvæ or pupæ, and my potted plants taken with me contained none.

* This is the species described as *Isosoma grande* in a previous part of this report (p. 358).—C. V. R.

On June 6, however, I was gratified to find females of the same form in considerable numbers ovipositing in wheat about Oxford, Ind. These were also provided with fully developed wings, and, in fact, I have yet to see a single example wingless or even with aborted wings.

The next day I found a pupa in a growing wheat-plant, and in another which was dying at the top precisely like the plant in the Bloomington, Ill., field, in which I found the pupa May 29, I found a fully developed adult alive, and, to all appearances, about to emerge.

In both cases the plants had reached the height of only a few inches, with scarcely any stem, but an unnatural growth of leaf.

The adults continued quite abundant until about the 18th of June, when they began to decrease in numbers. The last one noticed was taken on the 27th of the same month.

They seemed to fly about freely, and I found them in all fields of wheat or rye examined, even though the previous crop had been of corn, although they were considerably more abundant where the present was the third crop of wheat than where it was the first.

In every case, so far as I observed, they invariably oviposited directly in the upper joint, and their instinct in detecting its location even when covered with the sheath was infallible.

I feel quite confident, however, that future observations will show that they do oviposit lower down in the plant earlier in the season, when it is more tender. For while I have never found any indication that the young larvæ, after hatching, made their way downwards, their track upward was very apparent in the joint, and also the actual number of larvæ found in and above the upper joint later in the season fails to correspond with the number of females observed ovipositing. Moreover, I failed to find these adults any more numerous in fields where last year's straw stacks were still standing than where the straw had been removed and threshed elsewhere.

My experience has been that the larvæ of these *Isosoma* very seldom work downwards into the joint until full grown, and then only to excavate a cell in which to transform. This may at first appear to be a matter of small moment, but when we find that ninety-nine out of every hundred of these upper joints are removed with the straw, while, if the grain is harvested at the usual height, eight out of ten of the joints next below will, in all probability, remain in the field, we shall find that it may make a considerable difference in the future life of the insect whether it is located a little lower down or higher up in the straw.

I have secured abundant material, both of larvæ and of straw, in which I know the larger form has oviposited, but have not yet attempted to separate the two forms of larvæ.

Assuming that both are *tritici*, I find by a series of examinations made June 25, July 1 and 9, that of 90 straws from the same field, 81 contained 136 larvæ, the remaining nine being uninfested.

By examining the straw at different dates, the total number of larvæ would include many that would have been destroyed by parasites later, and also any hatched after the 25th of June. The number actually developing from 90 straws will be determined another year. These 136 larvæ were distributed in the straw as follows, each joint including with it the intervening space between it and the next above, or, if the first, between it and the head:

Number in first joint	17
Number in second joint	77
Number in third joint	32
Number in fourth joint	10

This field was harvested on July 11, being cut the usual height from the ground, and on the next day I examined 90 harvested straws and found in them 25 larvæ. This, I think, gives a fair idea of the percentage of larvæ the farmer removes from the field in the straw.

By a careful examination of the sheaves I found that, while the first joints were almost invariably removed with the grain, comparatively few of those of the second were included, the straw having in the majority of cases been severed between the two.

In this way, larvæ between the first and second joints, or in the latter, were at once placed largely at the mercy of numerous carnivorous foes, from whom they had previously been secure. The larvæ, in the majority of cases, where they had not already ensconced themselves in the soft walls of the inside of the straw, as they sometimes do, had burrowed down into the joint and lay awaiting the time when they were to pupate. They vary considerably in size, large and small being promiscuously distributed throughout the straw.

Parasites.—There are at least six of these which have to a considerable extent reduced the *Isosoma* larvæ in point of numbers. Two of the most efficient in this work are Hymenoptera (*Stictonotus isosomatis* Riley, and *Eupelmus allynii* French), which deposit their eggs in the infested straws in June, and by September 10 the young larvæ have hatched, destroyed their victims, transformed to the adult, and escaped from the straw. As soon as the grain is harvested the larvæ thus exposed, as previously explained, are rapidly depleted in numbers by two other foes.

One of these is the larva of a Carabid, *Leptotrachelus dorsalis* Fab., a slender, somewhat depressed larva 8^{mm} in length, which descends into the stubble and devours both the *Isosoma* larva and that of the Hymenopterous parasite, should it chance to be there.

When full grown it stops the aperture by which it entered with a pellet, constructed from bits of the interior substance of the stubble, which it tears off with its jaws, and in a short time enters the pupa stage, transforming to the adult a few days later.

Curiously enough, during the time it occupies the stubble in the larva and pupa stages it sometimes falls a victim to the second of these two parasites, viz., the mite *Heteropus ventricosus* Newport, which enters the stubble ostensibly for the same purpose, but whose sense of discrimination is rather poorly developed, and, although infinitely the smaller of the three, is finally victorious over the *Isosoma* larva, its parasite, and their mutual enemy, the *Leptotrachelus* larva.

This mite, whose habits I have studied before,* is a very convenient parasite, and will make its way where the others would fail, if there is the minutest avenue by which it can reach its victim. I shall refer to it again farther on.

WHEAT AND GRASS SAW-FLY.

(Family *Tenthredinidæ.*)

My acquaintance with this insect has so far been confined to the larvæ only, having first found it in that stage in considerable abundance on the 14th of May.

They were at this time feeding on the leaves of wheat in a field near Bloomington, Ill. At first I thought they came from a piece of woods

* See Twelfth Report of State Entomologist of Illinois, pp. 144–154. Bound in the Trans. Depart. of Agriculture of Illinois, Vol. XX, 1880.

near by, but later, when I found the larvæ abundant fully 3 miles from any woods, it seemed improbable that either larvæ or adults had—this year at least—been of sylvan habits.

I found very small larvæ in the center of a large wheat-field, much too far from the margin to lead to even the supposition that they had originated outside of the field.

When I first observed them they were from 4^{mm} to 12^{mm} in length, rather slender, and of a uniform green color. Toward the last of May, as they became more fully developed, there appeared to be two forms, differing somewhat in color and contour of the body.

One form when full grown was 20^{mm} in length, tapering very gradually but uniformly from the head posteriorly. Color green, with the exception of two narrow and rather indistinct lines along the back, separated by a narrow line of the same green color as the body, and a wider lateral white line just above the spiracles. Head green, eyes black, and mandibles brown.

Some individuals of this form became full grown, and on the 29th of May descended a few inches into the earth, and by the 31st had constructed brown cocoons. As there were many half-grown worms still on the plants in my breeding-cage, and as I afterwards found an immature larva near Oxford, Ind., on grass the 27th of June, I am led to believe that the season of oviposition is somewhat protracted.

The other form, when full grown, is 21^{mm} in length, with the thoracic segments—the first in particular—rather robust, the others gradually diminishing posteriorly. Although when young the larvæ have a greenish color, it gradually disappears as they reach maturity, the skin then being of a dingy white and, above, having the appearance of being drawn over a very dark substance beneath, which gives to the larvæ a slate-colored cast. It has, like the other, a lateral white stripe, but along the upper margin of this stripe is a row of black spots, one on each segment, and one on the neck; a black V-shaped spot at the base of the three anterior legs, and a short, interrupted, transverse black line across the base of each proleg, except the anal. The prolegs also have a black ring encircling them at the joint. Head with a faint tinge of yellow, eyes black, mandibles brown. Like the other form they mature from the last of May until about the 20th of June and descend into the earth. Both were quite abundant about Oxford, Ind., but were found much more common on timothy than upon wheat. They do not coil up upon the plant when feeding, but their movements when thus employed are much like those of the army worm (*Leucania unipuncta*) when similarly engaged. When disturbed they drop to the ground and remain in a coiled position perfectly motionless.

No adults have yet emerged from their cocoons in the earth, nor will they now be likely to do so before April or May.

On the 8th of May, before I knew anything of these larvæ affecting wheat, I found in a wheat-field near Bloomington, Ill., a small brown cocoon which, as I recollect, was like those which these larvæ construct.

On opening it I found it contained a green pupa. Both pupa and cocoon were placed in a box, but in my change of location the cocoon was separated and lost, the pupa failing to develop.

I am confident that it belonged to the same species as these larvæ under consideration, and was thrown up by the plow the fall previous in preparing the ground for this year's crop—wheat having been raised on the ground the preceding season.

Parasites.—While passing through a field of wheat, in May, I saw one of these worms a short distance from me with what appeared to be a

species of *Ophion* that had evidently just punctured it with its ovipositor and was still attached to it. But before I could secure them the *Ophion* had escaped and the larva fell to the ground, and I failed to find it.

In June I found a larva with the eggs of some species of *Tachina* attached to the upper surface of the thoracic segments.

THE WHEAT MIDGE.

(*Diplosis tritici* Kirby.)

I first observed the larvæ of this insect on the 6th of June, two days after locating in Indiana.

The larvæ have not been excessively abundant on wheat, and I do not think they have done any serious injury.

Their non-destructiveness, however, was, to a considerable extent, I think, due to the ravages among them of *Megilla maculata* and their larvæ, *Podabrus tomentosus* and three species of *Telephoridæ*, all of which were very abundant about the heads during June.

While I have detected all of these, with the exception of the *Megilla* larvæ, in the act of feeding upon the pollen, and the *Podabrus* feeding on the kernel, their movements unmistakably indicated that they were in search of other food. I did not make it a special point to study the midge until after the middle of July, when I placed a large quantity of badly-infested heads of rye in a box with earth in order to secure a quantity of larvæ.

From these heads of rye I bred, during the remainder of July, a considerable number of adult midges, and they also appeared occasionally in the box during August, although I had removed the head of rye on the 31st of July.

On August 29 I saw an adult on the outside of the glass of one of my breeding-cages in which I had growing wheat.

Several times since the 1st of September I have noticed a repetition of this, although my cages are at least half of a mile from any field where wheat or rye was grown the present season, or from where any has been threshed.

From the 4th to the 15th of September I not only found larvæ in considerable abundance under the sheath of volunteer wheat, but adults, too, in the same situation, and also on the outside of the plants and hovering about the upper leaves.

From a quantity of this wheat placed in a breeding-cage on September 7 appeared three or four adults. These were all removed on the 10th, but the second day after two others were found in the cage. The history of this volunteer wheat is as follows: During the time intervening between the harvesting and removal of the wheat from a field, stock from an adjoining pasture broke into the field, and in nibbling the sheaves in the shocks, shelled off and rattled downward to the gound considerable wheat.

These shocks were removed on August 14, the wheat thus shelled off immediately taking root and springing up where they had stood, and by September 1 had formed a thick mass of growing grain.

THE AMERICAN MEROMYZA.

(*Meromyza americana* Fitch.)

This species has been recently so thoroughly studied by Prof. S. A. Forbes in his second report as State entomologist of Illinois, that I made no special effort to follow it through the season, but kept it in

view, and I refer to it here in order to add a few observations to its history.

I have only observed it in the vicinity of Oxford, Ind., and my first note bears the date of June 6, when I captured two adults in a field of wheat.

On the 14th, in the same field, in a dwarfed stool about 3 inches high, I took a nearly full-grown larva, which had apparently followed the central leaf from near the base of the plant upward to a point slightly below where the upper leaves began to diverge, and hence was not at this time in the stem, but among the leaves.

On June 16 another larva, also nearly mature, was found in the upper joint of a growing straw in the same field. A week later, many withering heads were noticed in the field, the effects of the larvæ in the straws. Puparia were observed on June 24.

On July 18, adults, bred from straw obtained from this field a few days previous, were copulating, other adults continuing to appear up to the 26th. I have no record of them through August, but on the 5th of September swept a number of adults from volunteer wheat. Adults were bred from volunteer wheat October 1, and were swept from a field of young wheat October 6.

Parasites.—The mite, *Heteropus ventricosus*, was again encountered as a parasite, and as the Meromyza larvæ frequently cut off, either wholly or in part, the straws which they infest, these minute insects find them a much easier prey than the larvæ of *Isosoma tritici*.

Three times during the present season I have found *Dipterous* larvæ, other than this species, affecting the culms of wheat in much the same manner as the *Meromyza*, and up to this time, in two cases, have bred the adult. But my material and notes are not at this time in a shape to enable me to give a concise account of the life-history of these insects, and for this reason I prefer to let the matter rest until making my final report.

THE FLEA-LIKE NEGRO-BUG.

(*Thyreocoris pulicarius*, Germ.)

The study of this species was undertaken with the object of breeding, and thereby settling the date of oviposition and hatching; also of recording these and such other facts as I might be able to get in their life-history not hitherto published.

It is only recently that they have been known to affect wheat, and I have not observed them doing any great injury.

Adults were observed copulating on May 9, and were at once confined on wheat under glass, being fed on ripe strawberries. The females began to oviposit on the 20th, placing their eggs singly on the leaves and sheath of the grain.

On the 26th, after depositing a few eggs in the intervening time, they made their escape.

The eggs may be described as follows:

Length, $\frac{3}{5}^{mm}$; diameter, $\frac{2}{5}^{mm}$; form elongate, oval; and when first deposited the color is shining, very light orange, which gradually deepens until just previous to hatching, when it is a livid red. One of these eggs deposited on May 21 hatched June 6, the larvæ being $\frac{3}{5}^{mm}$ in length, brown anteriorly, and red, barred with brown, posteriorly; legs yellow.

June 7, adults were still observed in fields of wheat in considerable numbers.

I only saw the young on wheat in one or two cases during the season. And on July 24, adults, undoubtedly of the same brood, were observed congregated in great numbers on and about the buds of evening primrose.

THE TARNISHED PLANT-BUG.

(*Lygus lineolaris*, Beauv.)

I have here to add another to the long list of depredations of which this insect has been accused.

Late in June and early in July I observed both pupæ and adults puncturing the kernels of wheat and extracting the milk, thus causing them to shrivel and dry up, or to become moldy and discolored.

Although in numbers they were not excessively abundant, each time an individual satisfied its hunger in this manner it must necessarily have injured to a greater or less extent the kernel it punctured.

THE SOLDIER-BUG.

(*Podisus* sp.?)

An undetermined species of Podisus affected wheat in the same manner as the preceding, but in the larval as well as in the pupal and adult stages. Besides, being the more common of the two species, was probably the author of the major part of the damage. I have attributed to these two species and the wheat midge a damage of about 5 per cent. to the wheat in the vicinity of Oxford, Ind., but am not now able to draw the line definitely between the work of the midge and the two Hemiptera.

THE FIELD-CRICKET.

(*Gryllus abbreviatus* Serv.)

One of the objects of interest that I noted on my first excursion to the wheat-fields after my arrival in Indiana, on the 4th of June, was a considerable amount of stubble 2 or 3 inches in height in the fields of growing grain.

Scattered about some of these were the upper parts of the plants thus cut off, and while in some cases these straws were withered and bleached, others seemed freshly cut. Although I visited this field daily, and each morning observed a few additional freshly-cut straws, it was not until the 16th of June that I obtained any clew to the author of this mischief.

On making my usual rounds on this morning, I happened to observe one of our field crickets coolly cut off a fine straw, and on seeing me suddenly, it dodged out of sight. I noticed these crickets at their work a number of times afterwards, and found in their burrows tender leaves and often parts of the heads which they had evidently dragged from where they had felled them.

Judging from the nature of these fragments they appeared to prefer the tender leaves and stems to the heads, but fed upon both.

As the grain neared maturity, from the excrement about larger areas of harvested plots, and the elongate little coverts so thoroughly associated with our common gray rabbit (*Lepus sylvaticus* Bach.) being so frequent in the immediate neighborhood also, the inference was very strong that the crickets were not alone responsible for the injury. On

October 6, however, the cricket was again seen at work cutting off young wheat-stems.

INSECTS AFFECTING RYE.

All insects observed affecting this grain to any extent have previously been considered under the head of Wheat Insects, and hence it is not necessary to repeat them here.

I have noted several others injurious in fields of rye, but these will be considered in a later report.

The two grains, wheat and rye, are so closely allied that any insect found affecting one may be confidently looked for on the other.

INSECTS AFFECTING OATS.

Of all our small grains this is the least affected by injurious insects. Many species that are exceedingly destructive to both wheat and rye do not affect oats in the slightest degree.

A notable case is that of the larvæ of the Wheat and Grass Saw-fly, which will perish of starvation when confined upon fresh, tender shoots of growing oats.

No injuries of any moment to this grain have come under my observation, and I shall notice but one insect in relation to it.

THE STALK-BORER.

(*Gortyna nitela* Guen.)

On the 7th of May, while walking through a field of oats near Bloomington, Ill., I noticed that the central vertical leaf was, in numerous cases, withering, and in others dead and brown.

On examination of the affected plants I found that the heart of the stem had been eaten, and I had examined but two before I found a larva of a *Gortyna*, which in all probability was that of *nitela*, that was engaged in feeding in the young stem below the surface of the ground.

The larvæ at this time were from 2^{mm} to 3^{mm} in length, and I found them in the interior of the field 10 to 15 rods from the margin, a distance they could by no possibility have traveled. I found many young larvæ in the stems of grass along the margin of the field, some of which were larger than those found in the oats. I also found that these larvæ in the grasses moved from one shoot, as it withered and died, to another, and that the first soon became shriveled and disappeared, while from its base young shoots at once sprung up and took its place, so that the number of affected stems visible at one time offered no reliable data as to the number of larvæ infesting the grass or the number of shoots they had destroyed.

The field under consideration had been planted with corn the previous year, and on the 15th of the preceding month (April) plowed and sown with oats.

At the time of my observations the grain was about 2 inches high, and had, as yet, but one lateral leaf, and, as near as I could recollect, had made its appearance above the surface of the ground about the 22d of April. It is hardly probable that eggs were deposited in this field prior to this time.

The point at which the larvæ had entered the plants was plainly indicated by a small cavity near the lower extremity of the bulb just

above where the fibrous roots are put forth, which cavity connected with the upper channel in the stem.

As late as the 21st of May I found these larvæ, now frequently 5^{mm} in length, still working in the young plants, and, although making their way upward, they were still below the surface of the ground.

From the 7th of May until the 15th I examined many fields of later-sown oats, but could find no trace of the larvæ in them, neither in fall wheat nor rye, although they were abundant in the grass along the margin of these same fields, the stems of fall-sown grain evidently being too tough for the very young larvæ.

I also sugared for the moths every evening during this time about the grain fields, but obtained no moths.

These observations, I think, go to show the correctness of our present theory, viz., that the moths hibernate during the winter, and in the spring deposit their eggs in grasses, and from thence the larvæ distribute themselves over the fields later in the season. Or they may, as I have shown, oviposit on early spring grain.

I believe we shall find that these eggs are deposited, as a rule, prior to the 1st of May. I also believe that during the latter two-thirds of their larval stage these insects are rather more nomadic in their habits than we have supposed, or else are, when from half to two-thirds grown, overtaken with a mania for moving.

In sweeping grasses in June I have found these larvæ as abundant in my net as any other species, and frequently observed them traveling about from place to place. The first moths were taken at Oxford, Ind., on August 20.

REPORT UPON INSECTS AFFECTING THE HOP AND THE CRANBERRY.

By J. B. SMITH, *Special Agent*.

HOP INSECTS.

Having last year watched the Aphides until the crop was gathered, the poles stacked, and the old vines piled for burning, and having determined the probability that during the winter they lived on the roots in some form, I visited Cooperstown early in spring to watch for their first appearance. Cooperstown was selected because Mr. Clark had informed me that the Aphides had been found by him in grubbing, and because he had promised in all ways to aid me. Adverse weather delayed all investigation for a short time, but as soon as at all possible I carefully examined fences, piles of stacked poles, and neighboring trees, exploring all crevices of the fences, stripping loose bark from the poles, and very closely examining all possible hiding places. No trace of the Aphides was found. Meanwhile grubbing progressed. Grubbing consists in digging up all round the hills, exposing the roots, and trimming off all superfluous shoots and runners. Every advantage for examining the roots was therefore offered to me, and all the men were instructed to keep a sharp lookout. Yet, though the work was done in yards which last year were most infested, and though I dug down to the bed-root and carefully examined hills everywhere, not a trace of the Aphides could I find. Nor were Mr. Clark's researches crowned with better success. Later I learned from my correspondents in the hop re-

gion that no lice appeared at all during early spring, and later it required close search to detect them scattered here and there through the yards; and at no time did they become numerous enough to do any damage whatever. On the whole, the hop was remarkably free from all insect attack. I am able, therefore, to add nothing to my previous report on the subject.

CRANBERRY INSECTS.

THE CRANBERRY FRUIT-WORM.*

Last season I decided that the *Phycid* attacking the fruit probably deposited its egg either in the flower or on the young berry; and this season, when the plants began to blossom, I visited Cape Cod to watch for the appearance of the insect. In order that I might the more easily recognize the species, I obtained from Washington a perfect specimen, bred from material forwarded by me last year. During the first ten days of July the weather was decidedly unfavorable to insect life or to the rapid development of such forms as hibernated in the pupa state. There was more or less rain each day, and the nights were cold, often unpleasantly so, and the bogs were sodden. The plants developed rapidly and the berries were very generally set, and still no trace of the insect had appeared on bogs that every previous season had been badly infested. At last, near the middle of July, on a few bogs close to the shore, very sandy, and so high that they could not be flowed during the winter, I found a few specimens of the imago. I secured both sexes and confined them, putting with them both flowers and young berries. On July 11, the day after securing the above-mentioned specimens, I again visited the bog where they were found, and though I searched carefully and persistently, not a single specimen could be discovered. July 12, again visited the same bog, and without great search secured eight specimens, but this seemed to have exhausted the stock. These specimens I distributed among growers in order that they might make optical acquaintance with the insect.

On Sandy Neck, a point opposite Barnstable, across the bay, on bogs which also could not be flowed, a few more specimens were found, which were also distributed among growers. Nowhere was it common, and it always is difficult to start up. It is very sluggish and easily taken after its situation is ascertained.

Until July 16 I found occasional specimens on high, warm, and dry bogs, and then no more could be discovered. Now commenced the search for eggs, and gathering a large number of berries of all sizes, and blossoms, I carefully examined them and succeeded in finding where and how the egg is deposited. The egg itself is white, or with a faint yellowish tinge, elongate oval when laid, but soft, and adapting itself to the locality where laid.

No eggs were found on blossoms or very young berries; the largest berries were most certain to show an egg, and never more than one egg was found on a berry. The egg is laid on the lower end of the berry, in the scar left by the flower, and under one of the four trigonate flaps more or less covering that scar. It is therefore sheltered, and difficult to find and reach. The insects in confinement mated, and the ♀ readily oviposited; but as the number of berries was small, several eggs were laid on a single berry, and some even on leaves. In natural circumstances one egg only is laid on a berry. A few young larvæ were also found on the bogs, and one on a berry in bottle containing the cap-

* This is described as *Acrobasis vaccinii* on page 356.

tured specimens. The egg state, therefore, lasts but a short time—six to eight days—and the young larva on hatching spins a few threads as supports, eats for a day or two from the outside skin until it becomes $1\frac{1}{2}$ to 2^{mm} in length, and then burrows into the berry and enters upon the life-history recorded in my previous report. There is in consequence great difficulty in reaching either egg or young larvæ.

One feature observed is that the insect was found only on high, warm bogs, and that in some localities where last season the insect was very common there was no trace of it; *all these bogs, however, had either held the water very late or had reflowed.* In localities where the bog is low and wet there always is less attack of worm than in high, dry situations. Since leaving the Cape I have received specimens from one spot where no trace of worm was visible when I left; but they are nowhere common.

It is difficult to judge exactly how much shall be attributed to the effects of reflowage, and how much to the cold, wet spring, which destroyed so much vegetation as well as insect life. Certain it is that on about all high, warm bogs which either could not be flowed or where the water was taken off early, the berry-moth was found in some numbers, while on none of the low, wet bogs which had been reflowed was there any trace up to the 17th day of July. Later, I understand, a few appeared; but very few, compared with previous years. I would, therefore, recommend also that the bog be kept as wet as possible during July, and the ditches nearly full of water. In some places this would be injurious to the fruit after it had well set, but while the plants are in blossom the wet is rather favorable than otherwise. The effect of this would be to destroy most of the pupæ, or at any rate to so retard their development that the larva would not destroy more than one berry during its life-time.

THE FIRE-WORM.

(*Anchylopera vacciniana* Pack.)

This insect, the Fire-Worm, which had in previous seasons done so much damage, has this year been kept pretty well under control. Growers had generally adopted the suggestions of my report and personal advice given to such as I met, and had used the water where possible, and always with great benefit if not absolute success. Some have gone to large expense to procure sufficient water, and others have made great preparations in that line, so that this insect once so destructive will itself in the course of a few years be so reduced in numbers as to be comparatively harmless. In Cape Cod, tobacco steeped or boiled is still the favorite remedy, and is undoubtedly effective if applied thoroughly and seasonably; two applications at brief intervals are necessary, and from 1 to $1\frac{1}{2}$ pounds to a gallon of water should be used. The tobacco is said to have fertilizing properties. It is, however, very expensive. The kerosene emulsion has been used to some extent, and where judiciously used has proved successful; where there was no success the fault was with the emulsion, which was not perfect. Churning with a barrel-stave was tried by some, and of course the result was not as complete as desired, for the emulsion obtained was neither complete nor stable.

CRANBERRY LEAF-FOLDER.

(*Teras oxycoccana*, Pack.)

In my previous report I stated that this insect was not found in Massachusetts, and at that time I had neither succeeded in finding it myself, nor had any growers to whom I described it noticed it. This season

I found an occasional specimen on some unflowed bogs near the shore, and on Sandy Neck, a long, narrow isthmus, with a line of bogs between sand hills, I found that this was the only form. The *Anchylopera* does not occur there at all, but the *Teras* effectively replaces it. The habits of the species are sufficiently described in my previous report, and nothing needs be added. The practice has been at Sandy Neck to carry a large wad of rags soaked in kerosene and tied to an iron rod, blazing, over the bog in early evening. A vast number of specimens flew into this blaze and were destroyed. Needless to say, these bogs had not been flowed, else this insect could not exist. In New Jersey it has done no noteworthy damage.

An experiment was tried looking to an explanation of the dimorphism of the species. Eggs from gray ♀ ♀ were obtained in early spring, and the larva when hatched fed exclusively on old leaves and kept in a low temperature, the pupa often in a refrigerator; nevertheless, they all produced yellow imagines. These were mated and eggs obtained, and these, fed on fresh leaves, were separated into two groups. One lot was left continually in the same temperature, the other was changed—cold at night, hot during the day, the variation irregular—still from both lots I obtained yellow specimens only. The third brood is still in the larval state; these I shall keep at a uniformly high temperature, the object being, if possible, to make this last brood also yellow.

These, in brief, represent the results of my field work so far as the special crops investigated were concerned. The season has not been one favorable to the development of insect life; a late frost (June 14–16) killed many acres of cranberry vines, and probably much of the insect life; but even where the frost did no especial damage no unusual increase of injurious species was noted. The Berry worm is now known in all its states and the apparent remedies suggested; experience now and intelligent effort in dealing with the various stages will undoubtedly soon enable growers to subdue this enemy, as they can by sufficient exertion control the other pests.

A CECIDOMYID LARVA INFESTING THE PEAR AT MERIDEN, CONN.

[Plate IX, Fig. 6.]

In pursuance of your instructions of June 3, 1884, I went to Meriden, Conn., and called on the Messrs. Coe Bros., who are the proprietors of a fruit farm, containing, among others, some six hundred pear trees. The insect especially mentioned in your letter of instruction was a *Cecidomyid* larva, and to this insect my investigations were directed.

The injurious larva is a small apodous grub, of a bright yellow color, thickest in the middle, and tapering to each extremity, most evidently toward the head. When full grown it is about 3^{mm}, or nearly one-eighth of an inch in length, and the segments are subequal, and rather strongly marked. It is found in the infested pears, often in large numbers (from ten to twenty—in one specimen twenty-nine), giving them an irregular, somewhat knobby appearance, by which the infested is readily distinguished from the sound fruit. These protuberances are inconstant in size and appearance, sometimes merely causing the pear to appear unnaturally round, at others forming distinct and regularly convex protuberances. On June 6 and 7, when I was at Meriden, the insects were about full grown and had largely left the pears so that, especially on the Coe farm, few infested specimens were found; besides, to get rid of the pest on this farm, the heroic remedy of stripping the trees of all but a few

undoubtedly sound pears had been resorted to about a week prior to my visit, so that pears, sound or infested, were few and far between. The infested pears do not drop to the ground with the insect. On the contrary, they remain for quite a while afterward upon the tree, but slowly turn black and rot off. The second point in your instructions is thus definitely answered. As well as could be done in the small lot of pears remaining on the Coe farm, and rather better in a neighboring orchard where nothing had been done to get rid of the pest, the mode of reaching the ground was investigated, and the observed facts and information obtainable all point to the theory that the grub simply allows itself to drop. I believe this, first, because though I saw a few specimens on the outside of the pears near the opening showing the point of exit, none were found on the twigs near by, and nothing was found in the crevices of or under the bark; second, at one point where a basket of the infested fruit picked from the orchard had been allowed to remain over night the larvæ were found next morning in numbers, making the best of their way under ground, and Mr. Coe says that in some places, where the earth was a little loosened, he found large numbers. I dug somewhat at this point and found rather more than an inch under ground a number of specimens quite unchanged; they had been in the ground then about a week. Third, Mr. Coe says he has several times carried infested pears into the house and kept them in jars or boxes, and that the larvæ after leaving the pears had wandered round for some time, but had never pupated anywhere in or among the rubbish or crevices of the boxes. He had never placed earth in any of the boxes. As the larvæ found had been under ground certainly eight days, and were totally unchanged, the probability is that they remain in this form for some time before entering the pupa state. In the orchard it was impossible to do anything, because hogs, sheep, and chickens had everywhere rooted and scratched, so that even had not the infested fruit been removed it would have been difficult to find anything among the confused masses of sod and roots and grass.

On the Coe farm the insect has been known some five years, becoming each year more common, until last year it destroyed nearly the entire crop. It seems unknown except on the Coe farm and another orchard close by. In this latter place a few trees were found pretty badly infested, but no one had noticed it, and no one could give me any information as to how long it had been known. No other orchard in the vicinity of Meriden seems to suffer from it, and it is probably as yet confined to these two orchards. There is no other large orchard close by, and this may account for the fact that the species has not become more widely spread as yet. According to Mr. Coe, last year was a good year for pears, but his crop was largely destroyed; this year is an "off year" and there was not much bloom, so when it was noticed that the pears were generally infested, it was determined to strip the trees of all fruit that appeared at all infested, and so well did the men employed do their work that it was with difficulty a few specimens could be secured here. Six men were employed at the work for three or four days, and during that time stripped the 600 trees. Not all varieties of pear are equally attacked. The "Lawrence" is the favorite, and is a pear which though blooming later than others, yet sets first. Next is the "Anjou," almost equally infested. The "Bartlett" is not so much troubled, though by no means exempt, and on the "Seckel" but few of the insects are found.

As to the possibility of importation: Mr. Coe says that some seven years since he imported a large lot of pear stocks from France, upon

which were grafted American pears; prior to that time he had never seen the insects. A year or two afterward they were first noticed, but in small numbers, and since then have been on the increase. Mr. Coe is the only one in this section of the State who has imported pear-stocks, and his farm was first and for some time the only one infested. The probability is, therefore, that if the insect proves identical with the European species that it was in the pupa state in the lot of stocks received by the Messrs. Coe, seven years since. The eggs are probably deposited in the flower, as the larvæ are found in the young pear immediately after it has set. I could gain no information as to whether or no there was a second brood.

In view of all the facts gathered I did not consider it advisable to remain in Meriden to await the pupation of the insect, as it seems to me this can be better observed in the lot of larvæ sent to the Department.

As to a remedy, the simplest and most complete is that adopted by the Messrs. Coe. In an off year, strip the fruit from the trees and destroy it by burning after covering with kerosene, or feed to hogs immediately, before the insects have a chance to leave the pears. As it appears as yet to be local, there seems no reason why a year or two of this process should not entirely destroy the species, but of course there must be concerted action among the farmers, else the pest will keep on increasing, and not unlikely get beyond control.

NOTES FROM NEBRASKA.

By LAWRENCE BRUNER, *Special Agent.*

THE ROCKY MOUNTAIN LOCUST.

(*Caloptenus spretus.*)

During the present year the Rocky Mountain Locust (*Caloptenus spretus*) has appeared in small numbers at various points throughout Eastern and Central Nebraska, but at no place have I learned of its being in sufficient numbers to particularly injure crops, or even to cause, on the part of farmers, an apprehension of a future invasion. On the 18th of June quite a number of larvæ and pupæ were observed at a point about 2 miles to the east of Stanton, Stanton County. These were on the open prairie along the roadside, and upon investigation it was ascertained that very few, if any, had found their way into the neighboring grain fields.

Three weeks later, when the locality was again visited, it was found that most of the young had attained wings, and were already on the move, having spread over the surrounding country for a distance of a mile or more. Specimens were now observed to be quite plentiful within less than a mile of Stanton. Winged individuals were also numerous at the point where the young had been observed previously, and where they had in all probability hatched.

Inquiries have since been made regarding these locusts, but I have thus far been unable to learn of their further movements. It is supposed, however, that they simply spread over the adjacent country, and that nothing further will be heard of them.

I have kept close observation, and have made many inquiries during the summer in reference to locust flights, but have seen none nor have

I heard of any having been seen in the air at any point in this or other States.

Next to *C. spretus*, *C. differentialis*, the Common Yellow Meadow-locust, has attracted some attention the present year at many points in Western Iowa, and Eastern and Central Nebraska, where it seems to be largely on the increase. It has not exhibited any decidedly migratory habits so far as I am at present aware, but at different points has done considerable injury to vegetables, &c. Notably at Lincoln, on the capitol grounds, numerous large, almost black, locusts appeared, and, after partially defoliating the shrubbery and foliage plants, suddenly disappeared (R. W. Furnas). These were evidently the dark variety, often met with in Central and Eastern Nebraska. This locust, unlike the true migratory species, frequents low grounds and seems to multiply most rapidly during wet seasons. It also frequents such localities as are clothed with the rankest vegetation. I believe, however, that there is no reason to fear its ever becoming general in its distribution, at least in sufficient numbers to cause trouble, as there are too many odds against its great multiplication, and these are increasing annually.

The common Red Legged Locust (*C. femur-rubrum*) and one or two other allied species have also occurred in numbers a trifle above the normal condition of these species. These likewise need never be feared, for the same reasons.

THE SNOWY TREE-CRICKET.

(*Œcanthus niveus.*)

This common tree-cricket has been quite common, and will evidently be congregating in raspberry and blackberry patches, as well as on white willow hedges, where it often causes much injury by filling the stems and twigs of these plants with its eggs. Other plants are also deposited into. Several species of Helianthus and one Solidago are, however, its chief stand-by in this State. Scarcely a single one of these weeds escapes without the eggs of one or more of the crickets being thrust into its pithy substance. Aside from these few species I know of no other Orthopterous insect that has done or does special injury to crops or trees in the State.

THE CHINCH-BUG.

(*Blissus leucopterus.*)

About ten days before harvest or during the early part of July the Chinch-Bug began to appear in grain fields in great numbers throughout portions of Cuming, Burt, and Washington Counties, and much apprehension was felt by many for the safety of the crops.

Shortly afterwards several very heavy rains visited the region, and, as it would appear, almost exterminated the insect. Upon harvesting the grain it was found to be as good as or even better than usual, and no traces of the Chinch-Bug and its work could be found.

Whether the disappearance of the vast armies of this insect can be attributed entirely to the rains, or whether other agencies combined in the good work, I am at present unable to state, as I was too much occupied with other duties at this juncture to spend much time in investigating the matter. In conversing with several farmers regarding the sudden and wholesale destruction of these insects at a time when they

were supposed to be injuring crops on all sides, they all attributed the disappearance to the heavy rains, and thought that no other agency had assisted. Be this as it may, the fact that they suddenly did disappear remains unchanged.

CUT-WORMS.

During the latter part of May and early June several species of cut-worms were observed to be quite numerous in gardens and corn-fields in the vicinity of West Point, where they did some damage by cutting off the tender plants as they appeared above ground. The most abundant of these was the larva of *Agrotis saucia*. Some climbing cut-worms were also observed to work on the cottonwood and box-elder trees. These were, however, in small numbers.

THE IMPORTED CABBAGE-WORM.

(*Pieris rapæ.*)

This Cabbage pest has been steadily on the increase in Nebraska for the term of eight or nine years, the date when it was first observed by me to injure cabbages in and about Omaha. It has now become equally, if not more, numerous and destructive in the eastern and central portions of the State than in some of the older Eastern States, where it has existed in injurious numbers for many years. This extraordinary increase is evidently due to the absence of all or nearly all of its natural enemies, and also to the fact that up to the present time no special efforts have been made by our gardeners and farmers towards checking its rapid increase. As an example of the great numbers of this insect that are to be found in this section of country, I will mention a single instance that has come under my direct notice and which has had my personal attention. In a certain kitchen garden adjoining West Point, in which were planted seventy-six cabbages, and which the owner has endeavored to keep free from the worms by hand-picking, upwards of six thousand of them have already been destroyed. This estimate is not by guess, but by actual count. As large as the number thus destroyed may appear, there are still many worms to be found on these cabbages, the leaves of which have been much riddled with holes, despite the vigilance. At another locality, 16 miles to the southwest of this, the butterflies were observed in myriads, so to speak, hovering over a large field of beets, in the midst of which grew a few cabbages, and to which they appeared to be attracted from all directions. Among the few insects that destroy the worms in this State, several species of burrowing wasps* are quite conspicuous.

These capture the larvæ of all sizes, but chiefly those that are about two-thirds grown, and carry them away to their burrows where they are stored for food for the young wasps. I have also observed recently that during the cool, wet weather which we have been having, numbers of the worms of various ages have died from what appears to be a disease. When thus attacked they become limp, and turn a yellowish color, and afterwards mold. I have observed that such varieties of cabbage as have very solid heads and few base leaves, are less liable to injury than those in which the reverse is the case. Tough-leaved varieties are also less injured than the tender ones.

* *Sphex apicalis* Sm., *Ammophila vulgaris* Cr. and *Pompilus æthiops* Cr.

I have endeavored to find parasites that destroy these worms, but have thus far been foiled in the attempt.

I have, however, observed three species of Ichneumon flies creeping about upon the plants, which may prove to be parasitic upon it. Two of these are in considerable numbers, as many as fifteen or twenty of each having been observed in a single morning, while but two or three of the third have been seen.

Besides *P. rapæ* there are occasionally found the larvæ of *Mamestra picta*, *M. chenopodii*, and *Plutella cruciferarum*. These do not occur in hurtful numbers, and therefore amount to but a trifle as compared with *P. rapæ*.

Hand-picking is not an unprofitable means of ridding a small cabbage patch of these pests, but when two or more hundreds of the plants are to be gone over, some other means of destroying the worms will necessarily have to be resorted to, as, for instance, pyrethrum or petroleum. The substances, of course, can be best applied as described in your various recent reports.

FALSE-CATERPILLAR ON GRASS AND SEDGE.

(*Selandria* sp.) *

During June and the early part of July great numbers of saw-fly larvæ were observed to injure the grass on low, wet meadows at various points in the Elkhorn Valley and the valleys of the Loups. These were of two species, and evidently belong to the genus *Selandria*. In Holt County, where these larvæ were observed in the greatest numbers, the ground was entirely stripped of grass over small areas.

Although all sorts of grasses were attacked and eaten by the worms, they preferred the various species of Cyperus and Juncus to other varieties.

Whether these saw-fly larvæ have been equally numerous heretofore, or whether they have become so recently, I am unable to state. In some localities where these worms appeared in force, it was supposed that the army worm (*Leucania unipuncta*) had arrived, and therefore much needless apprehension was felt among the settlers.

No insect enemies were observed to attack them, neither could I learn of their being devoured by birds or reptiles. I have supposed, though, that the American bittern fed upon them at times, as this bird was frequently started from clumps of grass where the worms were in force, and at other times it was seen picking at something among the grass in which they were.

I have often found these larvæ in moderate numbers during other years while beating for insects along the margins of ponds, but never heretofore were they observed in such great numbers as they have been the present year.

INJURY TO WILLOWS AND COTTONWOODS.

For some years the large saw-fly (*Cimbex americana*) has attracted my attention at various points in Nebraska, by its habit of frequenting hedges of white willow in preference to the various species of the native

* The larvæ forwarded by Mr. Bruner were unfortunately in alcohol, and the imago, therefore, not reared, and for the present undeterminable.—C. V. R.

willow. During the summer its large, green, slug-like larvæ would be met with from time to time, but not until the present summer have I learned that it appeared in such great numbers as to completely defoliate the trees.

About three weeks ago (August 31) I visited Mr. G. M. Dodge, of Glencoe, Dodge County, and while driving across the country observed that nearly every hedge of this willow had been more or less injured by some insect which had stripped the trees of most of their leaves. I at once attributed the work to the striped cottonwood beetle (*Plagiodera scripta*), which, as you have shown, has been known to injure various species of willow, as well as the poplars and cottonwood in this and other sections of the country. Upon speaking to Mr. Dodge in reference to the subject, he informed me that the work was that of the above-named saw-fly. He also stated that the larvæ had been so numerous on many of the hedges in his immediate neighborhood as to completely defoliate the trees before they (the larvæ) had attained full growth, and that they had therefore proved the cause of their own destruction.

At other points, however, where the larvæ were less numerous, they have matured, and will evidently make their appearance in force next season, provided no unforeseen providence intervenes.

Mr. Dodge also informed me that this saw-fly has been steadily on the increase for the past three or four years—always working on the white willow in preference to the native species.

Another insect, and one that has been attracting general attention in portions of this and other Western States and Territories by its great abundance and general destructiveness to the cottonwood, poplars, and willows, is the Streaked Cottonwood Leaf-beetle (*Plagiodera scripta*).

The mature insect as well as the larvæ feed alike on the younger and more tender leaves and twigs, and thereby cause the tree to die in course of time if the attack be continued several years in succession. When the beetle is very numerous, all the leaves are eaten, and even the tender bark, upon the new growth, devoured. When this last is the case the trees have been known to die in a single year. This latter feature but seldom occurs, even when the season is very dry and the trees have been stripped.

There is a remedy in nature by which it is kept under control, viz., wet seasons following dry ones. Natural enemies are also doing much towards checking the otherwise enormous increase of this insect, and if left alone would very effectually reduce the pest during ordinary years. These are very nearly identical with those attacking the Colorado potato beetle. Among them various species of our common lady-birds (*Coccinellidæ*) are the most efficient. Their work is mostly confined to the destruction of the eggs, and perhaps a few of the newly-hatched larvæ.

As for birds, I have never known of their capturing and eating the beetle in any of its stages of growth, nor have I conversed with any one who has seen them do so.

The beetle is more highly favored on elevated, somewhat arid, ground where the tree growth is small and the temperature is low, than on low ground, where the conditions are the reverse, though it often thrives for a time even here. Rank growth in a tree thus affected is an advantage against the insect, and trees of this nature are seldom, if ever, killed by it.

I have always found this beetle to be more common near the mountains and upon the elevated plains of the West than elsewhere.

THE COLORADO POTATO-BEETLE.

This beetle has also been more numerous and destructive than usual at some points in Nebraska this past summer, completely stripping the vines of leaves, and even devouring the stems and potatoes when these latter could be reached. This did not occur, however, until late in the season, after the crop was far advanced and the tubers had all formed.

I am pleased to be able to report no considerable insect enemies to small grain in Nebraska this year. As requested, I have kept a close vigilance for insects injuring wheat, oats, rye, and barley, and only found one, the larvæ of a moth, working in the stems of rye. This was met with in moderate numbers only in one small field adjoining town, and specimens were at once forwarded to Mr. Howard, who, in your absence, pronounced it *Gortyna nitela*.

Aside from this, I have heard of no other instance of injury to the small-grain crop in the State during the year. There may have been, and undoubtedly were, a few Hessian flies in the grain fields of the river counties, as those counties which lie along the Missouri River are called, where it has been reported for several years. If so, they were in numbers so insignificant as not even to attract attention.

NOTES OF THE YEAR.

CHINCH-BUG NOTES.

Since the publication of a short article under this title in our report for 1881–'82, the occurrence of greatest interest in connection with the Chinch-bug has been, without doubt, its so-called "*invasion*" of New York State. In June, 1882, the work of the insect was first discovered upon the farm of Mr. H. C. King, of Hammond, Saint Lawrence County, some 3 acres of timothy grass being destroyed. In June, 1883, other fields upon the same farm were discovered to be in the same condition, and a search revealed the swarming destroyers both upon this and neighboring farms. Timothy, "June grass," and "wire grass" were alike destroyed, and great alarm was occasioned throughout the northern part of the State.

Specimens of the insect were sent to Mr. Lintner, the State entomologist, who published (October 10, 1882) a lengthy article in the *Albany Argus*, following it by articles in the *Country Gentleman* and in *Science*, and giving in the two first-mentioned papers a good account of the habits and life-history of the species and the best remedies proposed against it. Mr. Lintner also issued in the same month a circular entitled "Directions for arresting the Chinch-bug invasion of Northern New York," which was widely distributed and in which he predicted a continued increase in the diffusion and destructiveness of the bug and urged a prompt and full compliance with the directions which followed, and which consisted in a very good condensed summary of the best remedies and methods of prevention. The reasons for this prediction are here given in his own words:

It has planted itself, maintained a footing, and shown a rapid increase under unfavoring, unpropitious, and unnatural conditions such as these:

First. It is regarded as a Southern insect (extending farther northward, as do most animal forms, in the Mississippi Valley), yet it has appeared in the most northern county of the State and upon (if the report be reliable) the Saint Lawrence River.

Second. Its attack has been made upon timothy. This seems to be its most unusual food-plant, and, therefore, we infer, the least suited to it. All previous accounts concur in giving it a preference for spring wheat above all things else; next in order, oats or corn, and last, the grasses. Timothy is only mentioned as occasionally attacked by it.

Third. In all previous accounts great prominence has been given to its being a hot and dry weather insect, dependent upon these conditions not only for its multiplication but for its existence. Heavy rains have been claimed to be invariably fatal to it. It could not abound, it is stated, in a wet season.* Dr. Fitch had even made recommendation of sprinkling it with water (an artificial shower) as the best means for its extermination. In the present instance the bug obstinately persists in multiplying contrary to all rule. The past and the present have both been years of excessive rainfall in Saint Lawrence County. Spring, summer, and autumn have been exceptionally wet. * * *

It is shown by the above statements that the insect has rapidly increased and largely extended its area during the present year, under conditions which should have been fatal to it. Why it has been otherwise may perhaps find its explanation in the fact that it is a new introduction in this part of the United States, and that it is following the law well known to prevail in the introduction from abroad (Europe principally) of nearly all of our injurious insects. With scarcely an exception, with their importation they become far more destructive, causing greater ravages and often attacking new food-plants.

As the past history of the insect has shown that parasites and other enemies have entirely failed to arrest its multiplication, we are compelled to believe, from present means indications, that it has come to stay, and that it will do so unless effectual are taken to prevent it.

The following extract from a letter written March 20, 1884, in reply to inquiries that came through Dr. Loring from Hon. A. X. Parker, M. C., will show that our own experience with the insect obliged us to dissent from Mr. Lintner's views, and especially from his predictions:

* * * I have already expressed my views in reference to the exceptional injuries of the Chinch-bug in Saint Lawrence County, New York, as reported in the newspaper clippings sent by Mr. Parker, and as reported by Mr. Lintner, the State entomologist, in various publications last fall, and particularly in the *Albany Argus* of October 10, 1883, in *Science* of October 18, and in a circular issued from the office of the State entomologist of New York, October 18.

In the *Scientific American* of the latter part of November, 1883, and in *Science* (Vol. II, p. 621) my views will be found expressed. Mr. Lintner draws attention to the rarity of the Chinch-Bug in the State of New York heretofore; to its persistent injury in Saint Lawrence County, notwithstanding the past wet season, and finds in these facts reason for the greatest alarm, on the supposition that this manifestation is due to an invasion, and that the insect shows exceptional power of withstanding constant rains, which are well-known to prove disastrous to it in the Mississippi Valley. I have not been able to read over these accounts without feeling that an undue amount of alarm is felt. Since the Chinch-bug was known to occur in New York in the time of Harris and Fitch, and is found farther north both on the Atlantic seaboard and in the Northwest, I see no reason for the belief that Saint Lawrence County has been invaded from other parts, but should rather attribute the recent injury to undue increase of a species always there, although not generally noticed and even unrecorded heretofore. The sudden increase may be due to the excessively dry weather which characterized 1880 and 1881 and previous years, the reacting wet weather having not yet exercised an injurious effect upon it. In this view of the matter, which seems to be most reasonable, the outlook is rather encouraging than alarming, and I fully expect to see this view corroborated by subsequent events, *i. e.*, the pest will sink back into its state of harmlessness, and has probably perished in immense numbers during the past winter.

It is obvious that I do not share in the alarm which Mr. Lintner feels in reference to this exceptional increase and injury by this notorious insect, but that on the contrary I am inclined to the view that the farmers of Saint Lawrence County have good reason for expecting a cessation of such widespread injuries. These views, originally expressed last fall, have been further confirmed by subsequent report of recent chinch-bug injury in other sections of the East.

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* A year before this, in the Annual Report of this Department for 1881-'82 (p. 88), we gave an instance of the swarming of the Chinch-bug in immense numbers in parts of Illinois, Missouri, and Kansas in April and May, 1882, in spite of frequent rains.

Mr. Lintner's recommendations, with which the farmers of the affected region are undoubtedly familiar, are excellent, and I would strongly indorse them so far as they can be practically carried out, though it seems to me that they must necessarily fall short of being generally adopted without some obligatory legislation or some compensation from the State. At the present time the principal advice I would give would be to thoroughly burn all possible rubbish that may be accumulated about the farms and under which the mature insects may have hibernated. The leaves in adjoining forests should also be burned. The old grass in the meadows should be burned wherever it is possible, and, with the aid of a scattering of straw during a favorable spell of weather, most fields can be burned over. In addition to this, deep plowing and heavy rolling, especially in the higher and drier parts of fields that have already been infested, will prove useful auxiliaries.

So far as we can learn the present season the result has justified our prediction rather than that of Mr. Lintner. Although we have written repeatedly to Mr. King, the gentleman on whose farm the bugs were first noticed, we have been able to get no answer from him; but the papers have contained no notice of injury, while last year they sounded the note of alarm from Maine to Illinois.

From Mr. W. H. Knox, the statistical correspondent of the Department for Saint Lawrence County, we have received the following in reply to inquiries addressed to him:

CANTON, N. Y., *August* 7, 1884.

SIR: In reply to your inquiries regarding depredations of the Chinch-bug, I have but little to report. The town of Hammond had some trouble a year ago, though but a small area was affected. I cannot ascertain that there has been any trouble since. The probability is that no damage worthy of any consideration will be done this year in this locality.

Respectfully,

W. H. KNOX,
Statistical correspondent Saint Lawrence County, New York.

C. V. RILEY,
United States Entomologist.

NOTES ON THE GRAPE PHYLLOXERA.

The following correspondence is deemed of sufficient interest to warrant publication, as setting forth many of the well-established facts not generally understood in reference to *Phylloxera vastatrix* Planchon, and as indicating the limits within which legislative enactments for the prevention of its introduction from one country to another should be confined:

REGARDING THE GRAPE PHYLLOXERA IN RUSSIA.

BUREAU OF ENTOMOLOGY, *Washington, D. C., January* 22, 1884.

SIR: In reply to the communication of the honorable the Secretary of State of the 21st instant, inclosing one from Baron Struve, the Russian minister, asking for information in reference to the Grape Phylloxera, I have the honor to send you the following reply:

In reference to the efforts made and the results obtained in this country to destroy the Grape-vine Phylloxera, it will be necessary to a proper statement of the case to briefly give an account of the insect. The literature is so voluminous that it is useless to refer to particular works. Those in this country upon the subject are chiefly my own writings, contained in the 4th, 5th, 6th, 7th, and 8th reports on the insects of Missouri, published during the years 1871-1876. These are, unfortunately, State documents, and most of them are now scarce and very difficult to obtain. I transmit herewith, however, from my own library, the 6th, 7th, and 8th, which I beg Baron Struve will be pleased to accept. Some briefer articles on the subject will be found in the Department Reports for 1870, 1871, 1873, 1874, and 1878, which I would also suggest be transmitted. It is made manifest in these writings and has long been accepted in Europe, that the Phylloxera is indigenous to North America east of the Rocky Mountains, having always occurred on our vines from the time they were first cultivated. It does more or less damage to a few of our native vines, especially to those that are hybridized with the European vine (*Vitis vinifera*), but most of them

successfully resist its attacks. The European vine, however, succumbs in all parts of the world where the insect exists. In all other countries except the Eastern United States the insect is an importation. Hence, while different foreign Governments have found it necessary to enact laws and regulations to prevent its importation and spread, our own Government has felt no necessity for any such regulations, and whatever has been done to remedy the evil here has been accomplished by individual effort or by local or State action, as in some parts of California. It is true that under a misapprehension of the real facts some cuttings sent over to this country last spring were held by the New York authorities, and as it is germane to this letter I quote a portion of my reply to the letter of the Secretary of the Treasury upon this case, referred to me by you:

"The life-history of this interesting insect may be thus briefly stated: Starting from a stem-mother, it multiplies agamically through an indefinite number of generations, either in galls on the leaf or in cavities or on swellings on the roots. Its spread is naturally slow in the unwinged condition, whether on the surface or beneath the ground. But winged agamic females are produced during the late summer and autumn months, and these are the true migrants of the species, and disperse and spread from vineyard to vineyard through the atmosphere. They lay some half-dozen eggs only, in such situations as afford shade and moisture, and from these come only true males and females, which are mouthless, feed not, and are born simply to procreate, the female laying either below or above ground a single and the only directly impregnated egg, which has been termed the winter-egg, and which in the spring following gives birth to a stem-mother which may either found a colony in a gall on the leaf or upon the root, the latter being the more common habit.

"The prohibition of other products than grape-vines is based upon the supposed possibility of winged females settling thereon and depositing the few eggs which give birth to true males and females, which produce the winter egg. Now, the experiments which I made in 1875 (recorded in the Transactions of the Saint Louis Academy of Sciences, October, 1875), and which were the first recorded of their kind, show that the eggs from the winged females are most often laid in or on the ground near the base of the vine, and that they are so delicate as to require specially favorable conditions of moisture and temperature to enable them to hatch. I do not hesitate to express my conviction that when deposited on anything else than the lower tomentose surface of the living leaf of the grape-vine, where they can receive moisture by endosmosis, or in the crevices or irregularities of earth that receive from dew or other sources a due amount of moisture, they will infallibly perish. But even supposing that these eggs could hatch, and the resulting female should lay the impregnated egg on any other living plant, and that this egg should in due time give birth to the stem-mother, she would inevitably perish without issue for want of suitable food; while to suppose that all these operations could go on upon any other product or substance than living plants or upon the dry parts of plants is to exhibit crass ignorance of the peculiar conditions necessary to the perpetuation of the species at these particular stages. With the utmost care in endeavoring to supply the natural conditions, I have failed nine times in ten to obtain the sexual individuals, and still more frequently to get the impregnated egg, and such has been the experience of others in Europe. The danger of introducing this insect upon anything else than the grape-vine, where a voyage has to be made in the tropics, is yet more remote, as even supposing the winter egg could be produced, it would prematurely hatch on the voyage.

"The only way, therefore, in which Phylloxera can be conveyed from one country to another widely separated therefrom, is upon grape-vines. The recommendation to use certain resisting American vines as stocks on which to graft the more susceptible European vines has resulted in an immense traffic between this country and Europe in American cuttings, and nurserymen engaged in this business, however unbiased they may desire to be, naturally lean toward that side of the question which furthers their own interests. The insect may be carried on the roots of the vines during the winter either in the dormant larva state or in the "winter-egg" state, and while later researches here by myself and abroad by others have confirmed my previous experience in this country, published five years ago, as to the rarity of the winter egg on the canes above ground, and the more recent observations would seem to indicate that wherever it is thus found above ground it is produced rather from the gall-inhabiting type than from the more dangerous root-inhabiting type, yet the fact that this winter egg does occur upon almost any part of the plant above ground, and more particularly under the loose bark of the two-year-old cane, renders it quite possible that the insect may be carried upon cuttings in this winter-egg state, and fully justifies the prohibition of the introduction of such, as well as of rooted plants, from any country where the insect is known to occur. Indeed, considering the rarity of shipment of rooted vines, I strongly believe that the insect was originally introduced into Europe from America in the winter-egg state upon cuttings. I would say, therefore, to those countries desirous of defending themselves from the scourge, that all danger is removed when vines and all parts of vines from infested countries are kept out.

With such prohibition all requirements are met, and all legislation that goes beyond this must necessarily be hurtful to general industry, while the prohibition of traffic in American vines in countries where the grape Phylloxera is known to occur can have no useful end and may be detrimental.

"That the rarity with which the impregnated egg is found above ground greatly reduces the chances of Phylloxera introduction by cuttings is true; but in a country desiring protection from such a scourge the remotest chance should not be risked.

"While, therefore, I believe that the laws cannot be too stringent in preventing the introduction and the use of grape-vines in any living condition in a non-infested from an infected country, it is equally true that there is no danger in the mere passage through such a country of such vines or cuttings. These are necessarily boxed, and can be safely and properly shipped during the cold or non-growing season, when the egg is dormant, so that there is a practical impossibility in the introduction of the insect by the mere passage, whether of vines or cuttings."

It is obvious from what has preceded that the chief interest that the United States has in the Phylloxera question lies in two directions, first, the furnishing of cuttings of our own resisting varieties; secondly, the best means for our grape-growers to adopt to protect the susceptible vines from the attacks of the insect which universally prevails here. Immense quantities of these cuttings have been shipped to Europe during the last ten years. Outside of the use of such resisting stocks, which is one of the best measures in the way of prevention, bisulphide of carbon and prolonged submersion have hitherto been the most satisfactory means of contending with the foe. Some recent experiments at the Department, however, lead me to believe that kerosene emulsions will prove more valuable than anything hitherto tried in any country. The method of preparation of several of these emulsions is given in the Annual Report of this Department for 1881–'82, pages 112–116, and I would recommend that this report be also sent to Baron Struve, as well as Bulletin 1 of this Division. I first expressed this conviction as to the value of kerosene emulsions as against the Phylloxera, and referred to my experiments, at the last annual meeting of the American Pomological Society; but I have not yet published anything from the Department, as further experiments are still being made.

Respectfully, C. V. RILEY,
Entomologist.

Hon. GEORGE B. LORING,
Commissioner of Agriculture.

IN REFERENCE TO THE TREATY OF BERNE, AND THE PROHIBITION OF THE INTRODUCTION OF BULBS AND CUTTINGS FROM THE UNITED STATES INTO GERMANY.

BUREAU OF ENTOMOLOGY,
Washington, February 9, 1884.

SIR: I beg to submit the following report on the communication of Hon. A. A. Sargent, minister to Berlin, to the honorable the Secretary of State, which you have referred to me:

Certain American exporters of grape-vines (Messrs. Boelker & Sons, of New York) have complained to the Department of State concerning the exclusion of American plants from Germany, and Mr. Sargent reports upon the state of the German laws in reference to such importations.

It seems that Germany, by the imperial decree of July 4, 1883, prohibits absolutely the importation of grape-vines, cuttings, and roots. The importation of grapes and husks and of all other plants is allowed only to nations which took part in the Berne Congress of 1881, and then only under certain restrictions as to packing, certificates from official experts, &c. Thus Germany has gone a step beyond the provisions of the Berne Congress, and the stringency of the decree has caused great excitement and indignation among nurserymen in this country.

While no one can appreciate the necessity for stringent measures against the introduction of the Phylloxera into non-infested countries more than I do, yet certain of the provisions of this last decree appear to me utterly useless, and, without doubt, they cause much loss and annoyance to nurserymen in this and other countries as well as to those of Germany, without producing any corresponding benefit.

The clause in the decree prohibiting the importation of all "nurslings, shrubs, and other garden products not belonging to the category of the grape-vine, coming from nurseries and hot-houses into the Empire," is based upon the possibility of the winged females settling upon such plants and depositing the few eggs which give birth to the true males and females which produce the winter egg. I will repeat here, therefore, the conclusion which I have repeatedly urged in discussing restrictive legislation in reference to the Phylloxera, and which the habits and life-history of the insect justify.

The eggs from the winged females are most often laid in or on the ground near the base of the vine, and they are so delicate as to require especially favorable conditions of temperature and moisture to enable them to hatch. They must, in my judgment, infallibly perish when deposited on anything else than the lower surface of the living grape-leaf where they can receive moisture by endosmosis, or in crevices in earth that is kept moderately moist by rain or dew. But even supposing that these eggs could hatch, and the resulting female should lay her impregnated egg on any other living plant than grape, and that this egg should give birth in due time to the stem-mother, she would inevitably perish without issue for want of suitable food. With the utmost care to supply the natural conditions, I have failed nine times out of ten to obtain even the sexual individuals, and it is much more difficult to get the impregnated egg. European observers have had the same experience. From this it follows that the introduction of Phylloxera upon any other plant than the grape-vine, at any season of the year, is impossible, and hence the folly of the prohibition.

As to the possibility of its introduction upon grape-vines themselves, however, there can be no doubt. The insect can be carried on the roots of vines in the winter either in the dormant larva state or in the "winter-egg" state, and in this latter state it may occur upon almost any part of the plant above ground, more particularly under the loose bark of the two-year-old canes, although recent observations have proven that whenever it occurs above ground it is produced rather from the gall-inhabiting type than from the more dangerous root form. Therefore the clause which prohibits the introduction of cuttings with or without roots into districts where the Phylloxera absolutely does not exist, is fully justified by the facts. It may be well to state, however, that in districts where the Phylloxera exists no better preventive can be adopted than the introduction of the hardy and resisting American vines as stocks upon which to graft the more susceptible European varieties.

It should also be urged in this connection that, while the decree is justified in so far as it prohibits the actual introduction of vines and cuttings, there can be no danger from the mere passage through a non-infested country of such vines. These are necessarily boxed, and can only be properly and safely shipped during the cold or non-growing season when the egg is dormant; so that there is a practical impossibility in the introduction of the insect by such a passage.

While I am rather in the dark as to the nature of the original complaint (as no copy accompanied the papers received from the State Department), the United States can safely and with great justice urge upon Germany the reversal of that portion of the decree which does not apply to grape-vines proper.

Respectfully,

C. V. RILEY,
Entomologist.

Hon. GEORGE B. LORING,
Commissioner of Agriculture.

THE GRAPE PHYLLOXERA IN GRAPERIES—LEGAL QUESTIONS ARISING.

BUREAU OF ENTOMOLOGY,
Washington, November 5, 1884.

DEAR SIR: In making to you a final report of my conclusions in reference to the diseased condition of certain European grape-vines furnished by you last spring to Mr. Charles J. Osborn, of Mamaroneck, Westchester County, New York, and as to whether the Grape Phylloxera (*Phylloxera vastatrix*) had anything to do with such diseased condition, it becomes necessary that I summarize the points made in your various inquiries sent to this Department since the 1st of July last, and particularly those made since my return from Europe. The following facts become manifest from a review of this correspondence:

1st. The plants were obtained by you from the well-known firms of Ellwanger & Barry, of Rochester, and Hoopes Bro. & Thomas, of Cherry Hill Nurseries, West Chester, Pa., and shipped direct to where they were planted. They were grown in pots in the usual way, and they were planted in the borders of a new grapery the latter part of last February. They were strong two-year-old plants, to all appearance in splendid condition, made up of leading exotic varieties, Black Hamburgs, &c. The borders, from all reports, were carefully prepared last autumn and winter, the materials used being old rotted sod made into compost, with the usual proportion of bone-dust.

2d. About the middle of June, after the vines had made several feet of healthy growth, the lower leaf-stalks began to weaken, allowing the two or three basal leaves from the main shoot to droop. From the time that the vines showed a failing the cause seems to have been earnestly sought for, and the question as to whether it was due to Phylloxera injury raised. Finally, during July and August all parts of the

vine began to turn yellow, the Phylloxera was noticed upon the roots, and Mr. Osborn, his gardener, and yourself concluded that the insect was the cause of the unhealthy condition of the vines.

Assuming such to be the case, you wish to know whether it was possible that the insect got into the grapery with the material used for the border, or whether it could have entered in some other way?

On the supposition that the insect had been introduced on the vines you sold, you were held responsible by Mr. Osborn for their failure. This was the condition of the case when, on the 20th of September, you visited the Department and conferred with me in reference to the matter. I told you then that, from all the facts, I felt assured that you had arrived at a wrong conclusion in attributing the diseased condition of the vines to Phylloxera, but that I would postpone making you an official report until I had made a personal examination of the case. My conclusions are now quite definite, so that I feel warranted in reporting with assurance, from the examination made of the vine sent early in July, as well as of those received later, both from the Cherry Hill Nurseries and from Mr. Osborn's grapery, that the vines were healthy and exceptionally free from Phylloxera when they came from the nursery, and that even up to the time of their being uprooted and destroyed the Phylloxera work had at no time been sufficient to do them material harm. A root received October 2, and that had already been thrown away, showed no rotting, and so few traces of Phylloxera that I considered it exceptionally free. It should here be borne in mind that this insect occurs very generally over the country east of the Rocky Mountains; that no vineyard, unless in an exceptional situation, is free from it. Ordinarily, however, on the majority of our indigenous American vines, its presence results in little or no harm. Even in graperies it may almost invariably be found, but rarely in sufficient numbers to seriously injure the plants. Moreover, in its very worst manifestations, and upon those foreign vines most susceptible to its attacks, the vine does not succumb until the third year after the introduction of the insect. The disease in its acute form is well marked by a peculiar yellowing of the leaves, diminished growth, and absence of tendrils, while the root-system is generally entirely rotten. The presence of the insect in more or less abundance on the fibrous roots is no evidence of injury, but rather an evidence to the contrary, for so long as there are fibrous roots in abundance for it to attack, the injurious stage of the disease, namely, the rotting or decay of the larger roots, cannot be initiated.

From all these facts, and others that might be mentioned, I do not hesitate to say that Mr. Osborn's vines were not injured by the Phylloxera, and I feel that the digging of them up and casting them aside was the result of false and unjustified fears and imperfect knowledge of the insect. As to whether the insect was introduced from the nursery, or got into the grapery from surrounding vineyards, or was introduced in the sod, the probability as between the first and second suppositions is that it was introduced with the plants; for while the evidence shows that the plants were remarkably healthy, yet, as I have already stated, the insect is everywhere found in those parts of the country from which the vines came. A few of the insects may very probably have been on some of the vines, as they are almost sure to be on such as are two years old. That they were in the new-made soil is extremely improbable, as the insect is confined to the grape-vine, and could only have been thus introduced from soil taken from a vineyard.

This is as far as I feel justified in rendering a report from the standpoint of the entomologist. What the real cause of the trouble was I must leave to others, but upon consultation with Mr. William Saunders, the horticulturist of the Department, I find that it is no uncommon thing for vines planted as these were, in very rich, deep borders, to wilt and show evidence of disease in the manner in which the vines in question did, especially where they are kept too moist; so that the probability is that they languished from the character of the soil and of the treatment. This view is supported by a sample of the soil that I brought to Washington for examination, and also by the fact that I saw other potted vines in Mr. Osborn's grapery that had shown similar symptoms, but had not been thrown away, and were still living and promising well.

Finally, in the event of the Phylloxera becoming numerous enough to cause any injury, it would certainly be unwise to dig the vines up prematurely where the judicious use of kerosene emulsion or bisulphide of carbon would readily destroy the insects, and could be so easily employed under such circumstances as those surrounding Mr. Osborn's vines.

I have the honor to remain, yours, respectfully,

C. V. RILEY.

Mr. FRED. W. KELSEY,
208 Broadway, New York City.

MISCELLANEOUS NOTES.

THE BOX PSYLLA FOUND IN THE UNITED STATES.—While making some observations for the Bureau, Mr. Koebele found toward the end of May, in the garden of Mr. James Angus, New York City, large numbers of a Flea-louse infesting Box (*Buxus sempervirens*). The insects (at that time mostly larvæ or pupæ and a few imagos) thickly crowded the young growth of the plants and the whole hedge showed at the first glance a sickly appearance, the tender shoots being more or less yellowish in color and evidently dying. In our breeding cages the imagos continued to develop throughout the month of June, but outdoors no further observation on the life-history of the insect could be made. The species proved to be identical with the European Box Psylla (*Psylla buxi* Linn.), a species hitherto not known to occur in America. It is of a pale-green color with hyaline wings, the anterior and middle portions of the thorax (pronotum and dorsulum) having brownish, longitudinal markings, the larva and pupa being of still paler, uniform, greenish color and not deviating in form from the larvæ of other species of the same genus. The winged insect bears a deceptive resemblance to our native Horn-beam Psylla (*Psylla carpini* Fitch), and can only be distinguished from this upon close examination, the most obvious difference being the absence of a distinct pterostigma in the Box Psylla.

Mr. Angus attempted to brush the Psylla off with a stiff broom, but this is a remedy of very questionable value, and a much simpler and doubtless more effective way of getting rid of this pest would be the application of diluted kerosene emulsion in a very fine spray.

There is no danger that this newly imported Psylla will infest any other plant besides the Box, but, if not kept in check, it is liable to spread and to do serious damage to the plant in all those sections of the country where it is grown and esteemed as an evergreen ornament.

THE DWARFING OF OAKS BY MALLODON MELANOPUS (Linn.).—This beetle is one of our largest insects, being about two inches long, and very broad and heavy. Its larva is a cylindrical grub, or sawyer, about an inch in thickness and over three inches in length.

In Texas Mr. Schwarz found the larva of this Mallodon excavating its galleries in the heart-wood of the Hackberry (*Celtis*), a tree of the largest size. In Florida and elsewhere it feeds upon the Live oak, and it would seem that so large and powerful a borer was well chosen to be the destroyer of this giant among trees.

In point of fact, however, in its connection with this tree the beetle shows a surprising modification of its recorded habits. Its larva is found, not in the stem of the mature tree, so justly celebrated for its strength and toughness, but always in the root of infant trees, and usually in degenerate highland varieties of *Quercus virens*, or of its relatives, *Q. aquatica* and *Q. catesbæi*.

The mother beetle selects small saplings as a place of deposit for her eggs, which are laid in the foot, or collar, of the tree, just below the surface of the ground. How long a larval existence the insect has is not known, but it must extend over several years, since the roots occupied by these larvæ grow to a large size, while at the same time they show an entirely abnormal development and become a tangle of vegetable knots. In fact, the entire root in its growth accommodates itself to the requirements of the borer within. Very few new roots are formed, but the old roots excavated by the larva are constantly receiving additions of woody layers, which are in turn eaten away and huge flattened

galleries are formed, which are for the most part tightly packed with sawdust.

The beetle thus becomes, not the destoyer, but the parasite of the tree, and lives in a domicile, which may not improperly be termed a gigantic root-gall. The effect on the tree is to kill the original sapling, which becomes replaced by a cluster of insignificant and straggling suckers, forming perhaps a small clump of underbrush. In many cases the branches and leaves are barely sufficient to supply the materials for sluggish growth, and the entire strength of the plant goes toward the formation of a root plexus, out of all proportion to the growth above ground, and plainly designed to repair the ravages of the borer.

The Mallodon borers are very abundant in South Georgia and Florida, and as a result of their attacks, vast tracts which might otherwise have become forests, enriching the ground with annual deposits of leaves, are reduced to comparatively barren scrub, in which the scattered oak bushes barely suffice to cover the surface of the sand.

Many a new settler, seeing his sandy hillside covered only by insignificant oak bushes, and anticipating easy work in converting the wilderness into a blooming garden of orange trees, has been grieviously disappointed to find before him no light task in clearing from the soil these gnarled and tangled roots. In fact the great strength and weight of the southern grubbing hoe appears no longer a mystery when one contemplates the astonishing pile of "grub roots" which in vigorous hands it will extract from a few square yards of apparently unoccupied soil.

The results of the work of this beetle are very plainly visible around Savannah and especially on Tybee Island where Mr. George Noble first drew our attention to it; while Mr. Hubbard has carefully studied its work, as here recorded, in Florida.

THE CLOVER SEED MIDGE (*Cecidomyia leguminicola* Lintn.).—The first complaint of this insect which we have heard during the past two seasons was received early in September from Mr. C. Wakefield, of Allenville, Mifflin County, Pennsylvania. This is a new locality for the midge, but its abundance in Virginia and New York makes it altogether probable that it will be found in all of the intervening region. Mr. Wakefield states that the seed-crop in his section is being entirely destroyed; that the midges were bad last season, but much worse this fall. We gave an account of this insect, with figures, in the Annual Report of the Department for 1878, pp. 250–252, and additional notes will be found in the Annual for 1879, pp. 193–197.

THE POTATO STALK-WEEVIL (*Trichobaris trinotatus*, Say).—Vines containing this borer were received August 1 from Mr. Richard B. Taylor, of West Chester, Chester County, Pennsylvania. Mr. Taylor stated that two-thirds of his potato crop had been destroyed by the weevil, although he had seen no notice of loss by others. This insect was treated in our first report as State entomologist of Missouri, and was there figured in all stages. The only satisfactory remedy consists in pulling up and burning all infested stalks as soon as, by wilting, they indicate the presence of the weevil.

THE RED-HUMPED PROMINENT (*Œdemasia concinna*, Smith and Abbot).—This curious and well-known caterpillar was received in August from Oregon. Mr. F. S. Matteson, of Aumsville, states that he found it in large numbers on a young apple tree, entirely denuding the branches of leaves. This mention is made as bearing upon the geographical distribution of the species. The gregarious habits of these larvæ when first hatched admit of an easy remedy in hand-picking.

THE VARYING ANOMALA (*Anomala varians* Fabr.).—In July Mr. Eugene F. Barnes, of Marion, Marion County, Kansas, sent specimens of *Paria nigrocyanea* and *Anomala varians*, with a letter referring to them as a sample of a class of insects that had been causing great destruction among the wheat-fields on the highlands this year. The *Paria* was probably found feeding upon the leaves and inclosed by mistake with the *Anomala*, to which Mr. Barnes's remarks refer. This insect first appeared in his wheat-field about June 15, 1884, but on inquiry Mr. Barnes found that it had been at work [in the neighborhood] for nearly two weeks previously, destroying some heads of wheat and leaving others amongst them uninjured. They began work as soon as the wheat was in the dough. The wheat of one farmer (Mr. Harrison) was said to have been damaged 1,000 bushels. Upon being informed of the nature of this beetle and that a closely related species (*Anisoplia austriaca*) does great damage to wheat in a similar manner in Russia, Mr. Barnes replied that in his locality the beetles worked generally in wheat brought from Russia, as that section was peopled considerably by Russians.

WHITE-LINED MORNING-SPHINX (*Deilephila lineata* Fabr.).—Specimens of larvæ of this hawk-moth were sent us from Colorado Springs, Colo., on July 11, 1884, by E. B. McMorris, with the statement that these worms had appeared in immense numbers everywhere on the town site about two weeks previously, eating every kind of leaves on low plants, such as currants, gooseberries, and plums, but not ascending large trees. In confinement they ate each other. Chickweed (*Stellaria*) seemed to be a favorite food with them.

THE APPLE-TREE TENT-CATERPILLAR (*Clisiocampa americana* (?) Harr.).—In July Mr. C. H. Bliss sent specimens of caterpillars which had seriously injured fruit trees in Salt Lake and Utah Counties this year. These were so badly packed as to arrive in very poor condition, but appeared to be closely allied to, if not identical with, the common Apple-tree Tent-caterpillar (*Clisiocampa americana*) of the Eastern States. The habits, which Mr. Bliss carefully described in detail, were somewhat like those of the species mentioned. However, those worms were said to begin their ravages by devouring the terminal leaf of a twig, and then to spin a web which they lengthened down the limb as the leaves were devoured. When they got to be an inch or more in length they ceased to spin a web, but gathered in bunches on large limbs or the body of the tree. They remained in bunches at night, in rain, and in the heat of the day. When the leaves on one tree were devoured they went to another. When they had attained the length of an inch and a half they scattered everywhere, devouring grass, clover, lucerne, garden vegetables, shade trees, rose bushes, &c., and infested the houses and streets. They were choice in their food. They preferred apple, apricot, plum, and currant leaves; then next came the cherry, willow, and gooseberry. It was on these that the eggs were laid. The pear and peach suffered no damage. If the worms were disturbed when small they would loosen their hold of the twig and hang by a web. When larger they would throw their heads from side to side, let go of the twig, and fall to the ground. They were hatched in the first week in May, and dispersed about the 1st of June. About the 8th of June they began to spin their cocoons in the grass, clover, weeds, and trees, but generally on the fences and about buildings where they could get shelter. The first of them developed into moths in nineteen days. On June 27 Mr. Bliss saw some flying around the

trees early in the morning. Eggs were found abundantly on the trees on June 29. By cutting off the infested twigs while the brood was young, Mr. Bliss and other persons saved their fruit and trees, while persons who paid no attention to the matter had their orchards looking as if they were stripped by fire. The eggs can also be mashed or pulled off before they hatch.

CORN BILL-BUGS (*Sphenophorus robustus* Horn, and *S. sculptilis* Uhler).—On May 27, 1884, Prof. Jos. A. Holmes, of Chapel Hill, N. C., sent specimens of *Sphenophorus robustus*, known as "Kaloo bug" near Bayborough, N. C., stating that it is believed in the region from which these specimens came that the "insect winters in the rice stubble." "They were common in that region last year" and are said to be "often found about fallen green pine timber." A full discussion of the known facts concerning this species will be found in the report of this Department for 1881–1882, pp. 138–142, Plate 8, Fig. 2.

On May 22, 1884, Mr. M. T. [or M. G.] Stone, of Kellogg, Jasper County, Iowa, sent a specimen of *Sphenophorus sculptilis*, with a statement that this species of beetle had totally destroyed 60 acres of corn, planted on timothy sod, not leaving one hill in a hundred. Mr. Stone states that he has been farming 600 acres for sixteen years in Jasper County, and never saw anything like this insect before.

A SWARMING MITE (*Bryobia* sp.).—In May, specimens of one of the almost omnivorous species of the mite-genus *Bryobia* were sent by Mrs. I. H. Easterbrook, of Diamond Hill, Providence County, Rhode Island, with the statement that these insects were all over Mrs. Easterbrook's house, inside and out, where they were first discovered about the 8th of May. Mrs. Easterbrook found under the window-sills on the outside, webs where they seemed to be hatching. These mites are known to feed upon other insects and also upon many kinds of vegetation. Their appearance in immense numbers in houses has as yet not been satisfactorily explained, and such instances are rare. They can be readily killed with pyrethrum powder or with kerosene or benzine.

Specimens of the same were also sent in May by Mr. George N. Kimball, of Waltham, Mass., with a similar account of their habits. They should be carefully studied to see whence they originate and upon what they feed in such instances as these.

NEW ENEMY TO WHITE ROSES (*Euphoria kernii* Hald.).—On May 19, 1884, Dr. R. P. Talley, of Belton, Tex., sent specimens of *Euphoria kernii*, with the statement that these beetles are very destructive only to white or nearly white roses, but seem to originate, or at least to live, in the blossoms of a wild thistle which grows abundantly everywhere, especially on poor, rocky prairie soil. It is impossible to have a white rose mature after this wild flower makes its appearance.

A BEETLE EATING PEACH LEAVES (*Pristoscelis ater* Bland).—On May 17, 1884, Mr. Matthew Cooke, of Sacramento, Cal., sent specimens of *Pristoscelis ater*, with a statement that these beetles were found eating leaves of the peach in Fresno County, California. None of the numerous species of this genus occur east of the Rocky Mountains, and nothing is recorded of their habits and earlier stages beyond the fact that some of the species are frequently met with on various plants. We have some doubt as to the correctness of the observation.

EFFECT OF COLD ON EGGS OF BARK-LICE.—Mr. Joseph Voyle, of Gainesville, Fla., wrote as follows on March 4, 1884:

The young growth of the orange trees now shows the full extent of

damage done to it by frost during the past winter, the dead branches being conspicuous.

Examinations for effects of the cold temperature on Coccid eggs, on the trees, show that the vitality of the tree and that of the eggs of these insects yield to nearly the same temperature in a still atmosphere.

On branches where the outer ends are quite dead, and the part next the tree living, I find on the living part living coccid eggs.

One thing of importance I have noticed to be invariable—where the effect of the cold was enough to nearly kill the branches, if any one of them was infested by Coccids it was killed completely. Several instances in which on the same trees uninfested branches of large size are quite dead, examination shows that the Coccids had done, apparently, but little damage to some of these dead branches. In numerous cases where the trees were badly infested the branches are killed back to the trunk of the tree.

RAVAGES OF GRAIN WEEVILS IN FLORIDA (probably *Calandra oryzæ* L.).—On April 18, 1884, Mr. Joseph Voyle, of Gainesville, Fla., sent notes of observations made in a part of Alachua County, Florida, not accessible by railroads, where the old methods of farming prevail, on the variations of weevil damage in different corn-cribs, and the results of experiments made for reducing the damage done to corn by weevils. In this climate the work of the weevils is very rapidly done. Mr. Voyle's conclusions from his observations and experiments are that the corn should be sorted, the ears with long shucks for keeping, those with exposed or but thinly covered tips to be placed for first use; that, to keep well, the whole shuck should be gathered, not slip-shucked; that it should be packed away when the shucks are pliable—on a wet day, for instance; and that the doubling of the shuck back over the tip of the ear and placing each ear tip downwards is an important surety of success.

FULLER'S ROSE-BEETLE (*Aramigus fulleri* Horn).—On November 30, 1883, Mr. C. W. Minot, of Worcester, Mass., sent specimens of *Aramigus fulleri* found in his green-house. The favorite plant of this beetle was the Azalea, but it was also found on the Cissus. During the middle of the day the beetles perched as high as they could get, and hid as soon as they were disturbed in the least. They fed on the new shoots and tender leaves, and when a plant was allowed to stand alone they trimmed off the new shoots as fast as these shoots appeared. They disappeared about the first of January, and a new brood came out in the spring. Mr. Minot fed them on leaves of the "inch plant," in confinement, and they seemed to like these leaves. This insect was treated at length in our report as Entomologist to this Department for the year 1878.

THE BLOOD-SUCKING CONORHINUS (*Conorhinus sanguisuga* Lec.).—The following letter from Prof. J. G. Lemmon, of Oakland, Cal., is so interesting that we give it entire. The species proved to be that here indicated:

Herewith I send you a specimen—the only one now in my possession—of a monster blood-drawer, of the bug family of Hemiptera. We met with him, or rather he forced himself upon our acquaintance, with a dozen other insect annoyances, while we were botanizing the Santa Catalina Mountains of Arizona, in August last, and were compelled to pass a few nights in a small rock-lined cave on the southern slope.

We had accomplished a perilous exploration of a wonderful ravine, under a burning tropical sun, menaced on the way by eight large rattlesnakes of five different species; had killed several large, yellow, swift-running centipedes, had uncovered from the loose rocks a dozen scorpions, in the mean time fighting swarms of gnats that

insinuated themselves into our mouths, noses, eyes, and ears despite veils and wet towels, and now, at sundown, we sought the shelter of this cave, the locality of which we had discovered on a previous exploration, spread its rough floor with grama, prepared and ate our supper with keen relish, and lay down in our blankets for much needed rest and sleep.

Suddenly, about 10 o'clock, Mrs. Lemmon screamed, and rose up in bed, shaking her arm and exclaiming. Rousing up, lighting a match and searching the grass of our couch, a large, flat, black, nimble-footed bug was seen hurrying away into a rock-crevice.

The first bite was upon the arm of my wife, and it was pitiful to see the tears rolling down her cheeks as she swung her arm about, while applying ammonia to allay the pain of the wound, which immediately reddened and swelled, forming a convex surface one inch or more across.

After one hour or so, overcome by weariness we fell off to sleep, out of which I was aroused by a sting on my leg. Furies of Dante! How it hurt! Every ganglion of the nervous system seemed to be at once attacked. There was as much pain in the head as in the wounded leg. I caught the stealthy assassin and preserved him for our California Academy of Sciences. Other attacks during the night kept us awake for most of the long hours, but the next and succeeding nights, being overcome with fatigue and want of rest, towards morning the bugs had their way and gorged themselves with our blood while we were unable to combat them.

The swellings made by these monster bugs soon fester, with great itching and pain, then discharge pus from the wound for several days afterward.

From the size of this specimen, which is about medium, you see, when filled they are about the bigness and shape of a common hazel-nut. The specimen sent is about half filled with blood. Unlike the familiar fleas of Oakland and San Francisco, that first gallop along your spine and hold a picnic under your shoulder blades before proceeding to lunch off your shrinking veins, the presence of these terrible bugs is not felt until the keen thrust comes through your garments from their hard beak over $\frac{3}{16}$ of an inch long. It needs not, therefore, to crawl within your clothing or even your blanket in order to draw your blood.

A gentleman living in Tucson and owning a ranch near the foot-hills of the Santa Catalina recognizes this bug as an old offender, and states that some of the insects have wings with which they fly about his cabin, with a loud fluttering noise. We saw no winged specimens, however, and the gentleman may have referred to another insect nearly allied to this most dreadful enemy we met with in all our four years' exploration of Arizona.

THE CATALPA SPHINX (*Sphinx catalpæ*).—Judge Lawrence C. Johnson wrote from Selma, Ala., under date of November 11, 1883, concerning the fondness of the American cuckoos for the larvæ of this insect:

Last summer, speaking of the Catalpa Sphinx, it was mentioned how fond of them are the American cuckoos. After that, in July, lying ill a few days at a hotel in Eutaw, Ala., I could hear the well-known notes of these birds as if in uncommon numbers. A large water-oak (*Q. phellos*) shut out the prospect from my window; but the cuckoos frequently lit in it, giving me a good view of them. There they were, both species—*Coccygus erythrophthalmus*, and *C. americanus*. The latter is more numerous in the bottoms, but the river is only 2 miles away. The question with the sick man was, What could be drawing these shy birds into the midst of a city? As soon as I could walk out, the mystery was explained. Across the street stood a line of Catalpa (bignonioides). Every caterpillar was cleaned off of the upper branches. Not one to be found much defoliated, except very near the ground. In the river-bottoms, where in places the trees are plentiful, and hawks numerous, I have seen hundreds entirely stripped of leaves. A grove of this kind occupies a part of Gardiner's Island (Dallas County, Alabama), resorted to by fishermen to get the worms for bait.

NOTES ON COTTON-WORMS.—In November, 1883, Mr. G. H. Kent, of Meadville, Franklin County, Mississippi, wrote as follows in regard to the Cotton and Boll worms: The large, pale-green spider *Oxyopes viridans*, as well as *Clubiona pallens*, were destroying a vast number of worms and moths. A good many Aphis lions (*Chrysopa*), Mosquito-hawks and Soldier-bugs were observed searching among the cotton-plants for them also. The Thick-thighed Metapodius was found to be the most abundant insect in the cotton-fields, and Mr. Kent was convinced that they were destroying a great number of Aletias during the season. The Devil's Riding Horse (*Mantis carolina*) was also very

conspicuous among the destroyers of the caterpillars and other insects. "This past summer, after the 15th of June, being very dry, Aletias have been very scarce throughout our portion of the State."

Mr. Kent adopted the following plan as the best remedy to check the increase of *Heliothis* in the cotton-fields:

I commence planting about the 10th of April and chop the same to a stand by the first week in May, during which working I have early corn planted about five yards apart, three and four grains in a hill, which will be in roasting ears about the latter part of June. As soon as the ears were in that state I collected them and found from one to five worms, of different ages, on every ear. I gave the worms to my poultry and fed the corn to my stock. I planted a second time corn, as soon as the hoes went over the cotton again, and observed very little damaged corn amongst it.

Amongst other insects injurious to vegetation, Mr. Kent captured a very fine specimen of mole-cricket (*Gryllotalpa*). "These are very scarce in our part of the State, and are generally found in damp places, destroying potatoes and peanuts."

PYRETHRUM.—On June 8, 1884, Dr. F. H. Sims, of Thompson Cross Roads, Louisa County, Virginia, reported success in his efforts to obtain pyrethrum flowers from seed sent to him by this Department in May, 1883. About forty plants were obtained from the seed. These stood well the severe winter of 1883–'84, and came out in the spring green and vigorous.

On June 12, 1884, Mr. W. Allan, of McDonough P. O., Baltimore County, Maryland, reported success in the raising of pyrethrum from seed obtained two years since from this Department. At the same time he sent specimens of *Macrodactylus subspinosus* and *Chauliognathus marginatus*, the former of which was found on these plants in large numbers, and was apparently eating both leaves and flowers; the latter was not so numerous, and seemed to be more attracted by the flowers. A number of insects are known to feed on pyrethrum while it is growing.

NOTES FROM MISSOURI.

Miss Mary E. Murtfeldt, of Kirkwood, Mo., sends the following seasonal notes:

Taking one locality with another the Mississippi Valley suffered but little this year from the attacks of injurious insects. The familiar farm and garden pests made their appearance as usual, but seldom in such numbers as to excite apprehension. A few of the insects that were very destructive last year, such as the Striped Flea-beetle, did scarcely any damage here this season. On the other hand, several destructive species not heretofore observed in this locality occurred in considerable numbers.

The Colorado Potato-beetle (*Doryphora 10-lineata* Say), appeared in greater numbers than it has done since 1881, attacking the "Peach-blows" chiefly. The second brood of larvæ was much less than the first, however, owing to the attacks of natural enemies, and the potato crop was not perceptibly diminished.

The Striped Flea-beetle (*Haltica striolata*), which has been for several years excessively numerous and destructive to cruciferous vegetation was seldom observed in the spring and did no appreciable injury Cauliflower and early cabbage were consequently more abundant in ou markets and of better quality than for some years.

The European Cabbage Butterfly (*Pieris rapæ* Koch) did not make it appearance early in the season, but destroyed a large proportion of the late varieties, both of cabbage and cauliflower. It was also ruinous to

EXPLANATION TO PLATES

TO REPORT OF ENTOMOLOGIST.

Where figures are enlarged the natural sizes are indicated in hair-line at side, unless already indicated in some other way on the plate.

EXPLANATION TO PLATE I.

Rusty Oranges, showing the marked results of the work of the Rust-mite.

EXPLANATION TO PLATE II.

CABBAGE CUT-WORMS.

FIG. 1.—*Agrotis annexa*: *a*, larva feeding; *f*, pupa; *h*, ♂ moth—all natural size; *b*, head of larva from front; *c*, *d*, dorsal and lateral views of a middle joint—all enlarged; *e*, a portion of skin still more enlarged to show spinous surface: *g*, enlarged tip of abdomen in the pupa, from beneath. (Original.)

FIG. 2.—*Agrotis ypsilon*: *a*, larva, side view; *c*, ♂ moth—natural size; *b*, head of larva from front, enlarged. (After Riley.)

FIG. 3.—*Agrotis malefida*: *a*, larva; *f*, moth—both natural size; *b*, head of larva from front; *c*, *d*, dorsal and lateral views of a middle joint—all enlarged; *e*, more highly magnified surface of skin to show its minutely shagreened character. (Original.)

FIG. 4.—*Agrotis clandestina*: *a*, larva; *b*, moth—both natural size. (After Riley.)

FIG. 5.—*Hadena subjuncta*: *a*, head and cervical shield of larva; *c*, anal extremity of same from above—both enlarged; *b*, dorsal view of one of the middle joints of same, still more enlarged; *d*, ♂ moth, natural size. (After Riley.)

FIG. 6.—*Agrotis messoria*: *a*, larva; *b*, moth—both slightly enlarged. (After Riley.)

EXPLANATION TO PLATE III.

MISCELLANEOUS CABBAGE INSECTS.

FIG. 1.—*Agrotis saucia*: *a*, larva; *d*, moth—both natural size; *b*, dorsal view of larval head; *c*, dorsal view of a middle joint of larva—both enlarged. (After Riley.)

FIG. 2.—*Agrotis saucia*: *a*, single egg greatly enlarged; *b*, egg mass as deposited on a twig, natural size. (After Riley.)

FIG. 3.—*Agrotis devastator*: larva, natural size, and lateral view of middle joint of same. (After Riley.)

FIG. 4.—*Agrotis devastator*: ♂ moth, natural size. (Original.)

FIG. 5.—*Epicærus imbricatus*: adult, dorsal and lateral views, somewhat enlarged. (After Riley.)

FIG. 6.—*Phyllotreta vittata*: *a*, larva; *b*, adult—both greatly enlarged. (Original.)

EXPLANATION TO PLATE IV.

MISCELLANEOUS CABBAGE INSECTS.

FIG. 1.—*Phyllotreta zimmermannii*: *a*, larva; *c*, pupa; *d*, adult ♀; *e*, antenna of adult ♂—all greatly enlarged; *b*, mouth-parts of larva, still more highly magnified. (Original.)

FIG. 2.—*Murgantia histrionica*: *a*, larva; *b*, pupa; *c*, eggs; *g*, adult with closed wings; *h*, adult with wings extended—all natural size: *d*, eggs seen from the side; *e*, eggs seen from above—enlarged. (After Riley.)

FIG. 3.—*Capsus lineolaris*: adult—enlarged. (After Riley.)

FIG. 4.—*Capsus lineolaris*: *a*, first larva stage; *b*, second do.; *c*, first pupa stage; *d*, pupa—all enlarged. (Redrawn from Forbes.)

EXPLANATION TO PLATE V.

FIG. 1.—*Cimbex americana*: *a*, willow leaves showing egg-blisters from above and below; *b*, twig showing girdlings; *c*, egg; *d*, newly-hatched larva; *e*, *e*, full-grown larvæ; *f*, cocoon; *g*, do. cut open, with pupa; *h*, pupa, side view; *i*, female fly; *j*, her saw detached, side view; *k*, tip of do.—*c*, *d*, *j*, *k*, enlarged, the rest natural size. (Original.)

FIG. 2.—*Nysius destructor*: *a*, leaf, showing punctures, natural size; *b*, pupa: *c*, adult—both enlarged. (After Riley.)

FIG. 3.—*Monohammus confusor*: *a*, egg; *b*, newly-hatched larva—both enlarged. (Original).

EXPLANATION TO PLATES.

EXPLANATION TO PLATE VI.

FIG. 1.—*Oviposition of Monohammus confusor*: *a*, *a*, *a*, jaw punctures: *b*, one of them laid open to show position of egg—natural size. (Original.)

FIG. 2.—*Gelechia cerealella*: *a*, full-grown larva; *b*, pupa; *c*, ♀ moth; *d*, wings of a paler variety—all enlarged; *f*, grain of corn cut open to show larva at work—natural size; *g*, labial palpus of ♂ moth; *e*, egg; *h*, anal segment of pupa—all greatly enlarged. (Original.)

FIG. 3.—*Ear of pop-corn showing work of Gelechia cerealella*. (Original.)

EXPLANATION TO PLATE VII.

FIG. 1.—*Monohammus confusor*, bark showing exit perforations of mature beetles. (Original.)

FIG. 2.—*Isosoma grande*, section of straw showing (*c*) oviposition of the female—enlarged. (Original.)

FIG. 3.—*Isosoma grande*, female (*b*) in the act of ovipositing in wheat stalk—enlarged. (Original.)

FIG. 4.—*Aphis brassicæ*: *a*, so-called "male"; *b*, wingless viviparous female—both greatly enlarged, natural size indicated by the small outlines. (Redrawn from Curtis.)

EXPLANATION TO PLATE VIII.

FIG. 1.—*Plagiodera scripta*: *a*, egg mass; *c*, newly-hatched larvæ; *d*, *d*, *d*, larvæ of different sizes; *e*, pupa—natural size; *b*, single egg; *f*, one of the middle joints of body of larva from above, showing tubercles—enlarged. (After Riley.)

FIG. 2.—*Plagiodera scripta*: *a*, beetle, normal form: *b*, *c*, *d*, *e*, showing variations—natural size. (After Riley.)

FIG. 3.—*Isosoma grande*: *d*, larva; *g*, pupa—greatly enlarged; *f*, mandible of larva; *e*, two-jointed feeler—still more enlarged. (Original.)

FIG. 4.—*Isosoma grande*: adult female—enlarged. (Original.)

FIG. 5.—*Anthomyia brassicæ*: *a*, larva; *b*, pupa, dorsal view: *c*, female fly; *d*, head of male fly; *e*, antenna, showing its appearance in both sexes—enlarged. (Original.)

FIG. 6.—*Oscinis brassicæ*: *a*, larva; *b*, pupa; female fly; *d*, antenna of do.; *e*, p thoracic spiracle of larva; *f*, mandi or "breast-bone" of do.; *g*, anal spira of do.—enlarged. (Original.)

EXPLANATION TO PLATE IX.

FIG. 1.—*Early stages of Simulium piscicidium*: larva, dorsal view, with fan-shaped pendages spread; *b*, pupa, dorsal vi *c*, same, lateral view; *d*, same, vent view; *e*, thoracic proleg of larva; *f*, rangement of bristles at anal extre —enlarged. (After Riley.)

FIG. 2.—*Simulium molestum*: adult—enlar (After Packard.)

FIG. 3.—*Mouth-parts of larva of Simulium*: *a*, tion of a ray of the fan; *b*, mandi *c*, maxilla; *d*, under lip; *e*, upper l enlarged. (After Osten Sacken.)

FIG. 4.—*Acrobasis vaccinii*: *a*, immature c berry, showing egg; *g*, cocoon—nat size; *d*, larva; *e*, pupa; *f*, anal j dorsal view, of same; *h*, moth; *b*, side view; *c*, do., viewed more f above. (Original.)

FIG. 5.—*The Orange Rust-mite*: *a*, dorsal view lateral view—enlarged, the dot in c indicating natural size; *c*, leg; *d*, with embryo just about to hatch— enlarged. (Original.)

FIG. 6.—*The Pear Cecidomyia*: *a*, larva, d view; *b*, do., lateral view—enlarge head and anterior joints; *d*, anal j *e*, "breast-bone"—still more enl (Original.)

FIG. 7.—*Phyllotreta albionica*: beetle enlar (Original.)

EXPLANATION TO PLATE X.

PULVINARIA INNUMERABILIS.

FIG. 1.—*a*. egg before hatching; *b*, egg after h ing; *c*, newly-hatched larva, ve view—greatly enlarged, natural si dicated in circles. (Original.)

FIG. 2.—*a*, leaf with male scales—natural siz single male scale; *c*, male dorsal vi enlarged. (Original.)

FIG. 3.—*a*, female scales in Fall—natural do., dorsal view; *c*, do., ventral v enlarged. (After Forbes.)

FIG. 4.—*a*, *b*, females with egg-masses in late S on maple leaf and stem of Macl natural size. (After Riley.)

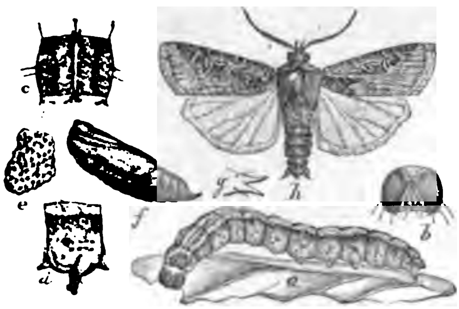


Fig. 1.

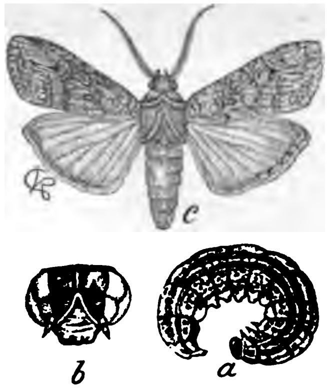


Fig. 2.

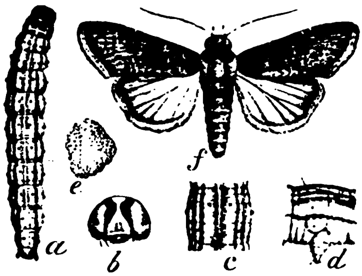


Fig. 3.

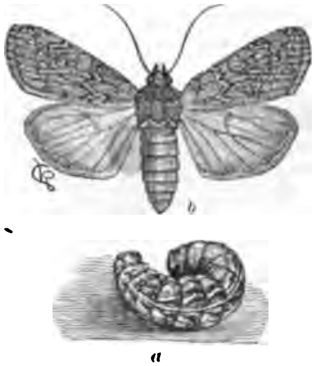


Fig. 4.

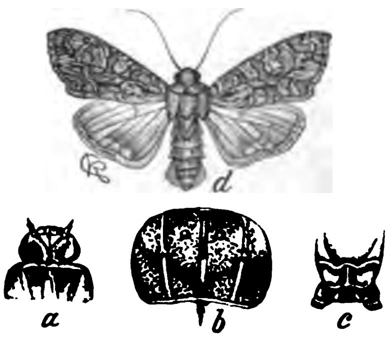


Fig. 5.

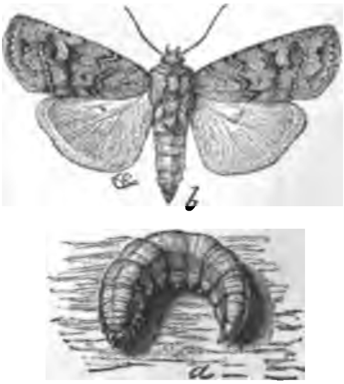
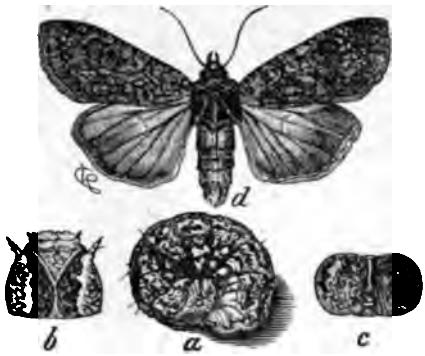


Fig. 6.



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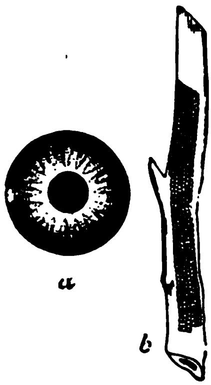

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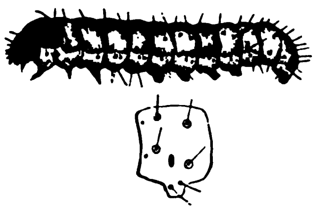

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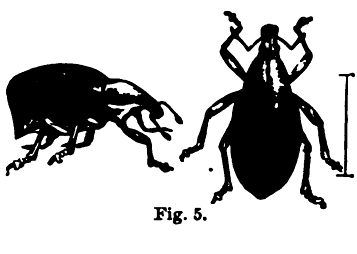

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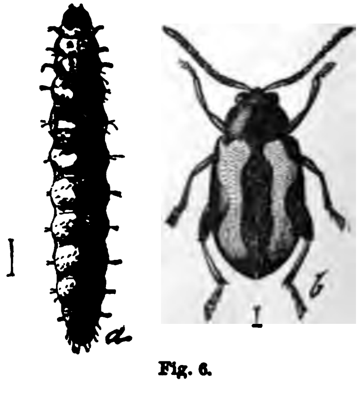

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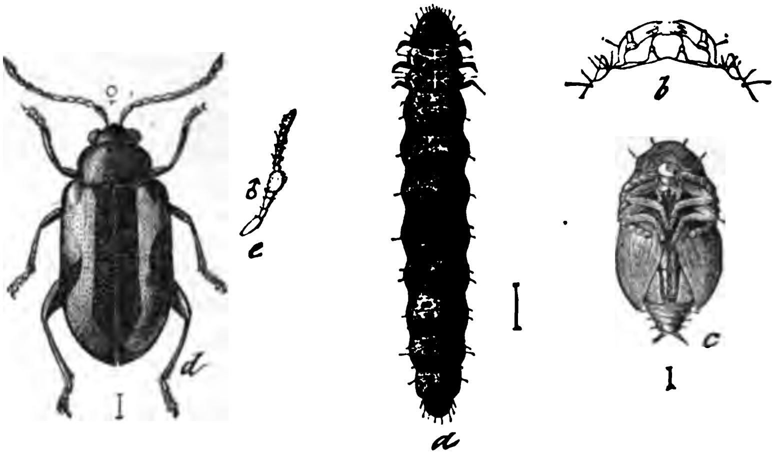

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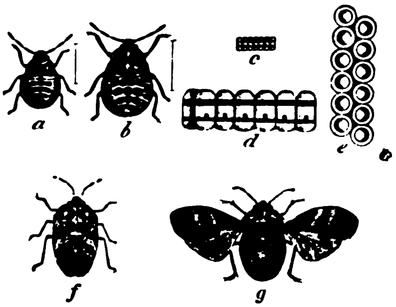

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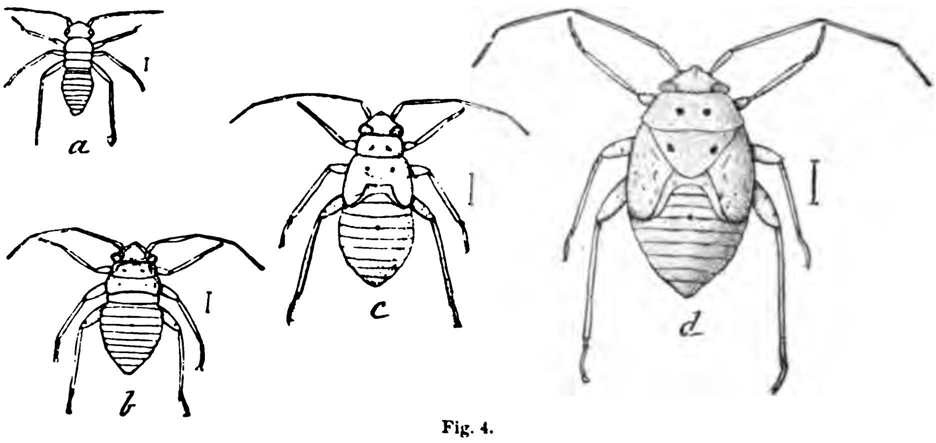

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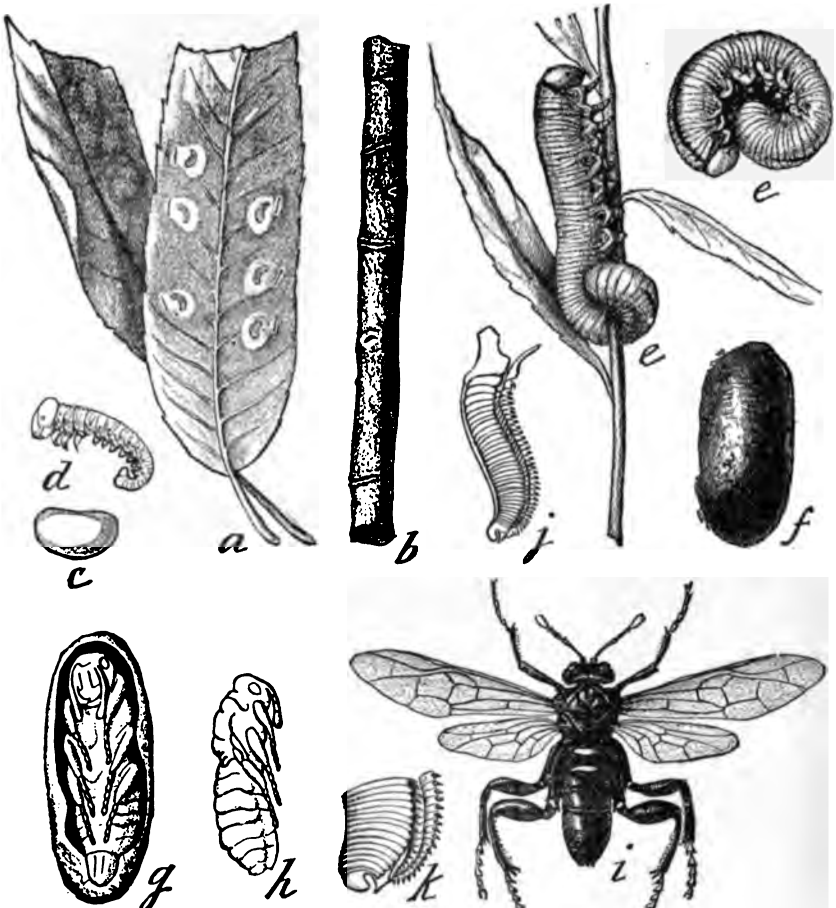

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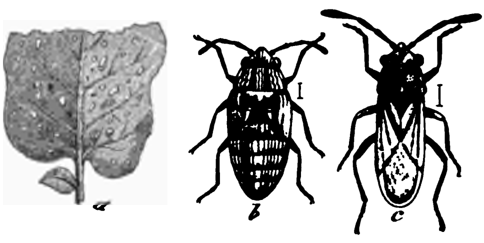

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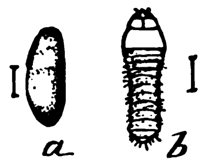

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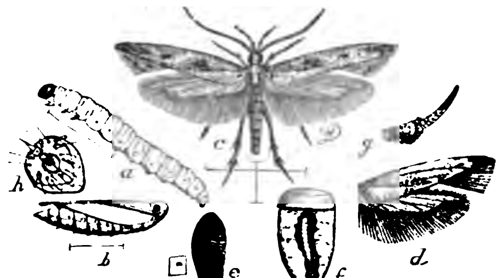

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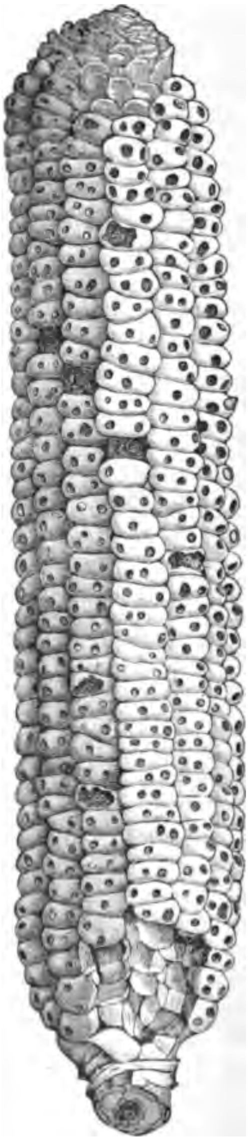

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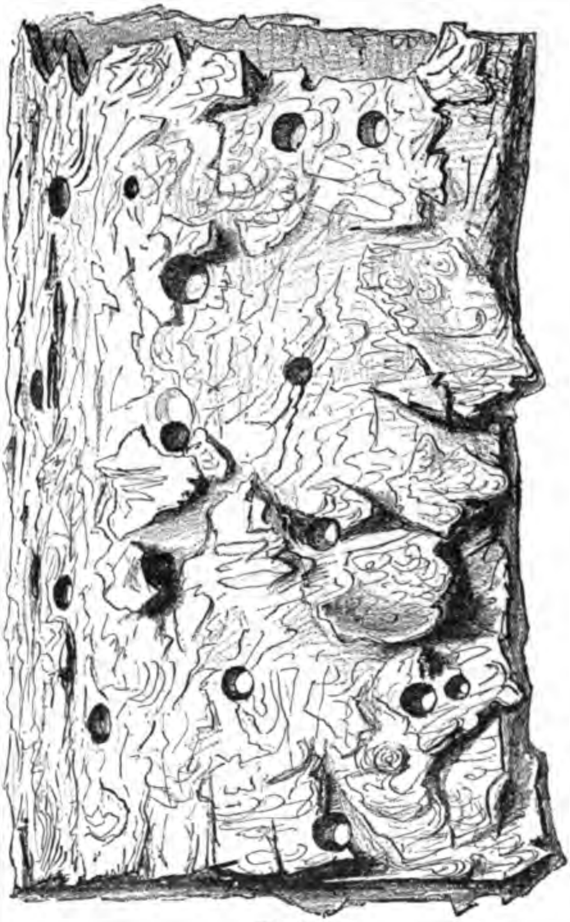

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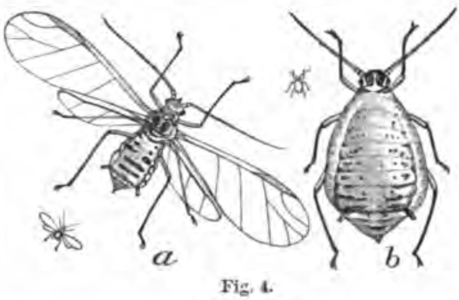

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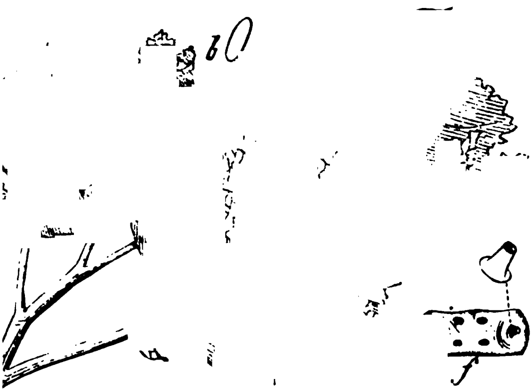

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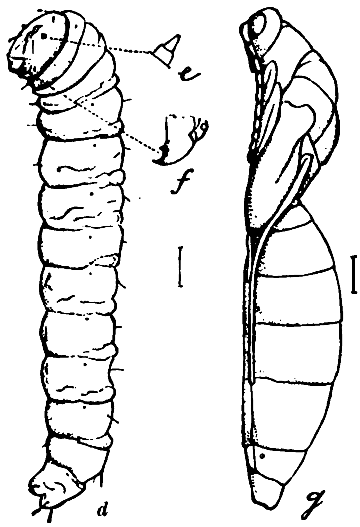

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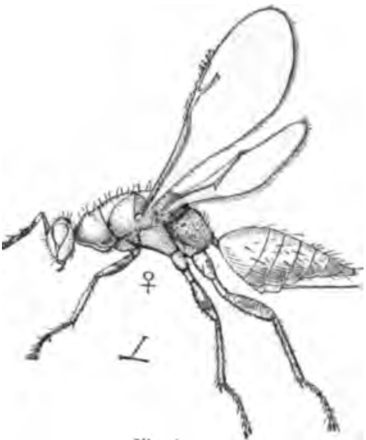

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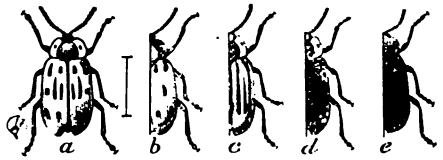

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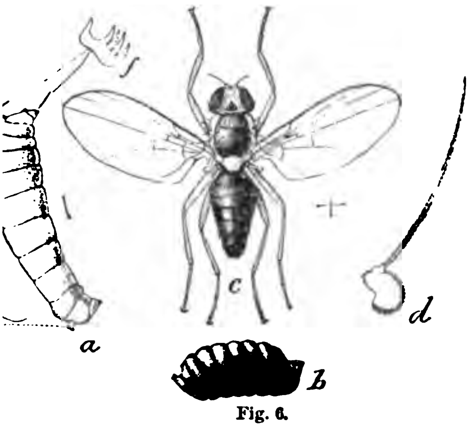

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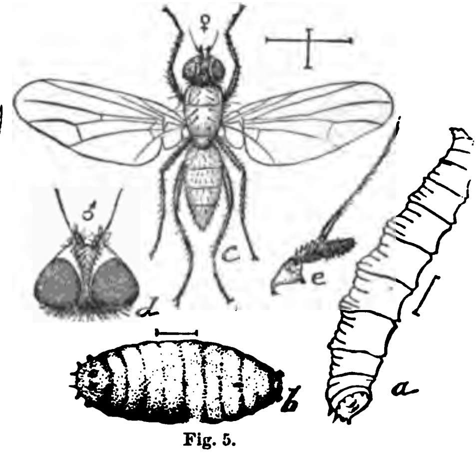

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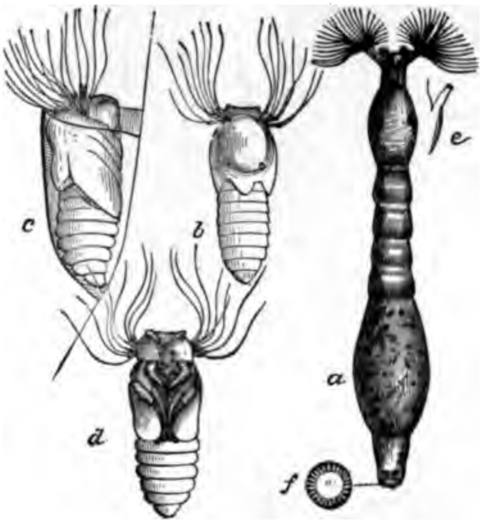

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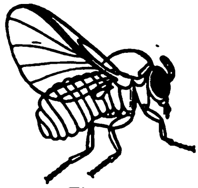

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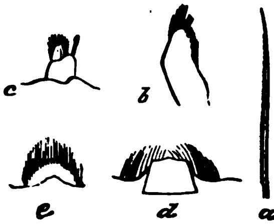

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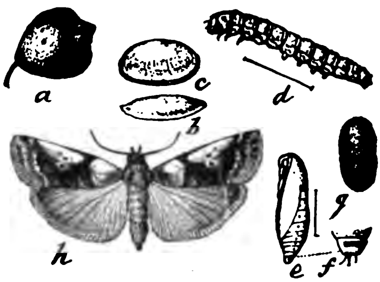

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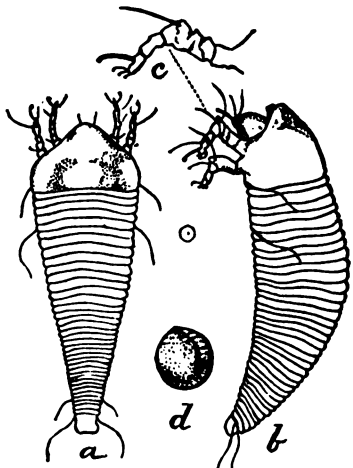

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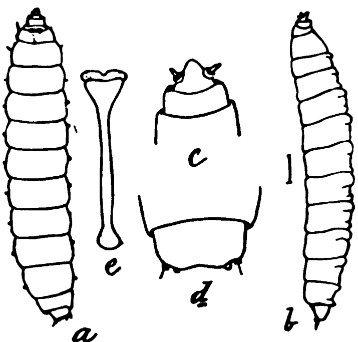

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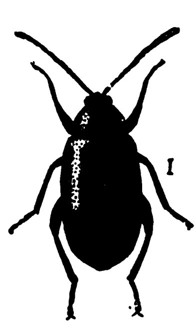

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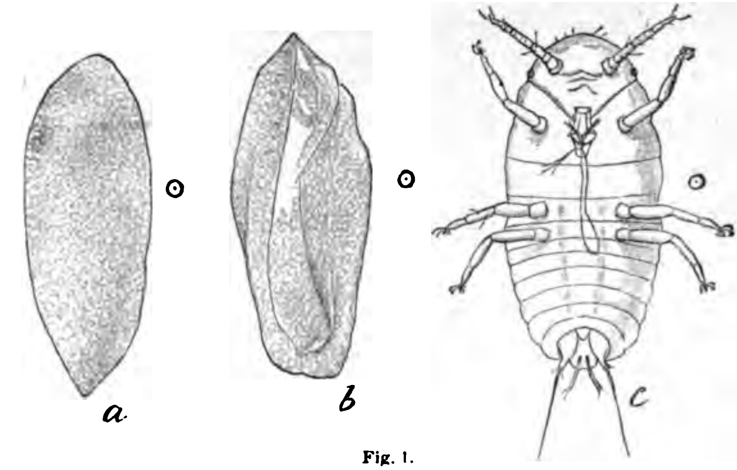

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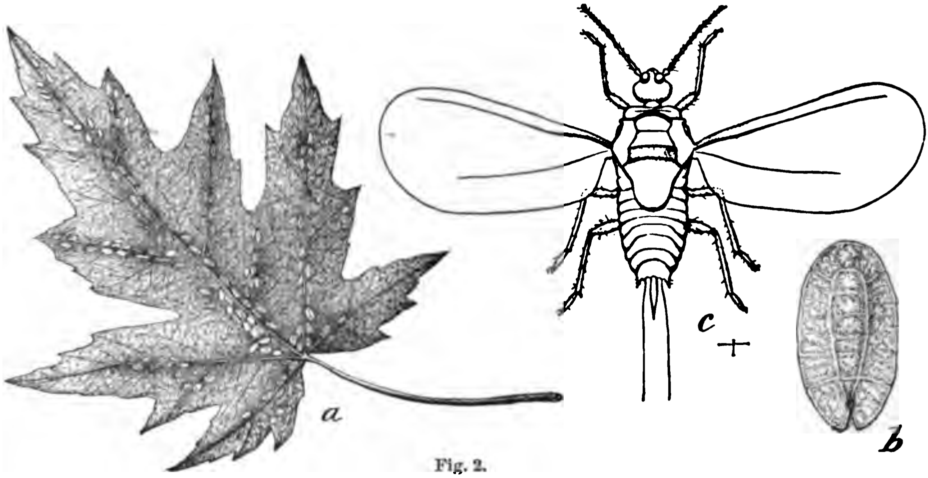

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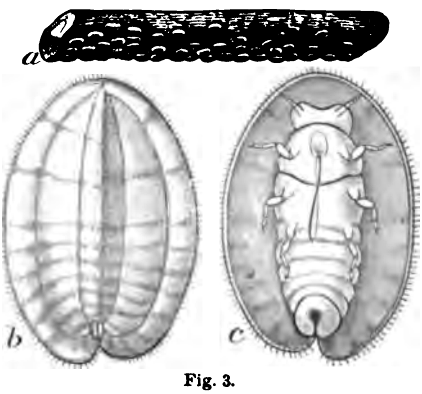

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beds of mignonette, and fed with almost equal voracity on the peppery leaves and stems of Nasturtiums (*Tropæolum*). I reared a large number of larvæ collected from various localities and at all ages, in the hope that some would prove to be parasited, but did not find any that were. On several occasions I found small larvæ impaled on the beaks of the Spined Soldier-bug (*Arma spinosa*).

The remedy used with entire success was hot water. This was taken from the fire at the boiling point, but by the time it had been poured into the watering-can and carried to the garden the temperature was so reduced that it did not in the least injure the plants, while it killed every worm that it touched.

The Cottony Maple Scale (*Pulvinaria innumerabilis* Rath.) was reported during the month of June from many localities in Missouri, Illinois, and Kansas. Its attacks were not confined to the maples; but it occurred in great numbers on the elms and sycamores, and as the infested trees soon began to show its effects in sickly foliage and interrupted growth, much popular apprehension was excited. The insect did not appear in Kirkwood, but the white cottony masses were very abundant on the trees that shade the city sidewalks and ornament the parks. The smaller branches and twigs of some of the trees were completely covered. Large clusters of this Coccid would also be found on any new wood that was forming over wounds on the trunk.

The only remedy that I could suggest, in response to numerous inquiries, was the saponaceous kerosene emulsion, to be applied with a syringe or fountain pump. On examining some of the scales collected in Lafayette Park in July, I found a small red mite (*Eupodes* sp.?) in large numbers evidently feeding on the eggs. Subsequently I found a small brown *Psocus*, apparently engaged in the same good work. The English sparrow will have an opportunity during the winter of redeeming its character in a measure by feeding on the egg-masses of this destructive Coccid. Whether it will do so remains to be seen.

The Stalk-borer (*Gortyna nitela* Guen.) was often made the subject of complaint during the past summer. In and around Kirkwood it was quite destructive to young shoots of blackberry, and in the course of the season I found it in almost all kinds of stems, including sprouts of maple and apple. The following item shows its capacity for destruction in the nursery:

ENEMY TO PEACH BUDS.—In working among my young peach buds which have grown about one foot I observed some of them drooping, and on investigating the matter found a little, gray worm about one-half inch long and the thickness of a thin knitting needle. The place where the insect stung the shoot I could not discover, as it must have healed over where the puncture was made.

In cutting off the shoots thus affected they were found to contain a worm, without exception.

Had usually gone about 2 inches, leaving the stem hollow behind them. All the trees thus affected die above where the insect works; and must start out from below again, which retards their growth and disfigures the young trees somewhat.

I would advise those who have young peach buds to look after them and destroy these little pests.

Although some of the natural shoots were stung, they seem to prefer the buds.

All I could find were destroyed, so as to keep them from increasing if possible.—S. MILLER. (*Rural World*, June 12, 1884.)

The worm referred to was the species named above, and in a subsequent letter Mr. Miller informed me that the loss he had sustained from the ravages of this insect was far greater than he had at first supposed. Last year I reared a single specimen of the large, white-marked *nebris*

variety from a stalk of *Cacalia suaveolens*. This year, from the stem of some weed, of which I made no especial note, I obtained a small, almost golden variety.

Grapholitha prunivora Walsh.—The larvæ of this pretty Tortrix were found in a large proportion of the Early Richmond and Morello cherries that dropped from the trees early in May, when about the size of large peas. In this case there was some defect in the instinct of the parent moths, as the stung cherries invariably dropped before sufficiently swollen to furnish the amount of nutriment required for the development of the larvæ, which accordingly perished when about half grown. I also found these larvæ, as in previous seasons, in the cockscomb elm-galls, feeding on the aphides and their sweet secretions.

Selandria vitis Harr.—This Tenthredinid made its appearance this summer for the first time in the vineyards of Kirkwood and vicinity. It was not destructively abundant, but may become so in the course of a few years. Its gregarious habit, however, betrays its presence and renders it comparatively easy to keep in check. The larvæ succumb quickly to the effects of pyrethrum powder as well as of hellebore.

Selandria sp., on plum. This gelatinous slug occurred very abundantly in May on all the cultivated plums, and did considerable injury to the foliage. I did not find it on any other tree, nor would it feed on the leaves of any other variety of *Prunus*, even the most closely allied. The second brood of the larvæ was, from some cause, less than the first in numbers, and the September brood, which hibernates, did scarcely any damage.

Early in the summer the foliage of the ash trees (*Fraxinus americana*) was much eaten by a Tenthredinid that I have not yet been able to rear, although I have observed it for several successive years. The slug is about the size of and very similar in appearance to *Selandria vitis*, being pale green, with small, immaculate black head and a double transverse row of short black spines on each segment. It inhabits the under surfaces of the leaves, and in feeding perforates them with round holes, of sizes corresponding with its stage of growth. It enters the ground about the last of May and incloses itself in a frail earthen cell. It seems to be but single-brooded, and in the rearing-cage either dries up or molds, without changing to pupa, in the course of the summer.

REPORT OF THE STATISTICIAN.

SIR: I have the honor to submit the twenty-first report of the operations of the Bureau of Statistics of the Department of Agriculture, it being my sixteenth annual report as Statistician.

The collection of statistics is made an important part of Department work by the organic act of 1862, but the organization for statistical work did not occur till 1863, when an appropriation was made for the salary of a Statistician, and $20,000 appropriated for the expenses of collection and compilation.

The duties of the Statistician are, the collection of the current facts of American agriculture and the compilation of such foreign statistics as may seem, by comparison and suggestion, to advance the interests of rural economy in this country. The facts of production, of distribution, of experiment, of values, wherever recorded, official or otherwise, foreign or domestic, are laid under contribution, are co-ordinated and marshaled for such natural and logical deductions as may aid in advancing the progress of scientific and productive agriculture. The official statistics of boards of trade, of industrial associations, of railroads, and all other available data are used.

The crop reporting system involves an organization of a corps of correspondents, one chief observer in each county, with three assistants in different parts of the county. They are charged with reporting, upon blanks furnished, the status of crops on the first day of each month, showing, as the season progresses, the comparative area planted, condition of growing crops, the average yield per acre, and the comparative product at the end of the season, with the average farm prices in December, upon which are based the values of the several crops. These reporters are selected for their known intelligence and judgment, and the aid of agricultural societies, or, in their absence, of the Representative in Congress, is invoked in their selection, if suitable persons are not known to the officers of the Department. They are selected with reference to *fitness*, and their political views are usually unknown. Their duties are performed gratuitously, in a spirit of self-sacrifice for the public good, and with an ardent desire to co-operate with the Department for general as well as local progress in agriculture. They are undoubtedly more efficient than a force of mere stipendiaries, and are entitled to grateful recognition of their valuable services. It is a subject of regret that the Department has been unable to supply its statistical corps promptly with the annual reports which they help to make and on which many of their comparisons are based.

In 1882, in the development of this system, a further test of accuracy was provided. State statistical agents were appointed, one for each State and Territory. They were paid a salary, small, but proportioned to the work demanded, and they were required to organize investigations parallel with those of the original corps reporting to the Department. As far as possible the heads of the State statistical system were

selected for this work, that national and local effort should be on the same line, and that any discrepancies appearing might be harmonized and verified. The State agent, as an assistant to the Statistician, could examine in detail the local peculiarities which explain the changes of area or product that constantly occur, and give greater thoroughness and accuracy to the published reports.

The correspondence of the Bureau is various and extensive, including compilation from records and original research, for Congressional committees, members of Congress, editors, authors, and others. There is necessarily a limit to this work, but scarcely a limit to the demand in this direction.

METHOD OF CROP REPORTS.

Crop reporting has always held important relations to prices, but its methods were formerly very crude and unsatisfactory. Neighborhood gossip of rural regions formed and expressed local public opinion on production, without much of system or calculation. The newspaper of days not very remote gathered up these opinions, loosely expressed, of uncertain meaning, and presented them without much analysis or interpretation, mainly because they were susceptible of neither. In recent days, with development of official systems, crop reporting has become popular and more practical, and much improvement in method has resulted.

There are a few points essential to the value of a crop report:

1. Its estimates must have a common measure of value, meaning the same to every reader, and susceptible of tabulation with similar statements.

2. They must each cover a definite territory. Thousands of individual reports, however accurate, are worthless without a knowledge of the precise area covered by each. One report which covers the corn acreage of McLean County, Illinois, may refer to a production of twelve million bushels, while a dozen others, reporting detached areas of other counties in the same State, would not together represent a million bushels. In this fact lies the worthlessness of many a pretentious effort in crop reporting.

In the Department system, reports are made by counties, making it possible to perfect an average. If an increase of area of 5 per cent. is reported, it is necessary to know whether the report represents 1,000 or 10,000 acres. The following explanation of "the meaning of crop-reporting figures" is given for the benefit of those who are not familiar with our methods:

There is occasional inquiry as to the meaning of figures used in crop reporting. The standard of comparison, 100, in reports of condition of growing crops, means that the plants occupy the ground fully, exhibiting a complete "stand"; that they appear in full healthfulness, uninjured by disease or insects; and that they have a medium growth for the date at which the report is made. It means a condition of full development that can only be exceeded by some luxuriance of growth. Hence it is absurd to report 150 for condition for most crops. It would misrepresent the comparative capacity for production. Cotton, for instance, with medium growth and a full healthy stand, promises better results than with great luxuriance or excess of "weed," which postpones fruiting and gives smaller results, unless the date of killing frost should be unusually late, in which case a larger yield might accrue. But great growth of stalk in a short season is dreaded by cot-

ton-growers. So with wheat and other cereals; excessive growth is not to be desired, as a large yield of grain is more valuable than abundance of straw, which is still burned by many wheat-growers. In the matter of hay, luxuriance of growth is an element of importance, and some enlargement of the standard, some increase above 100, is admissible.

It will readily be seen that "condition" cannot be expressed in bushels or pounds. There are no bushels of corn in a field just sprouting, and it is a misnomer to call first growth a final product. It is the result of characteristic American haste thus to discount the experiences and accidents of the whole season, and say that three inches of potato-vine above the surface means 90 bushels of potatoes per acre. Absurd blunders in crop-report reading have often been made in that way. Some of the most positive failures in the potato crop have followed a condition of average healthfulness and good growth on the 1st of August. The months of August and September determine the potato harvest. Yet the report of condition on the 1st of August, if favorable, will be sure to be quoted in September or later, when the crop has been destroyed, as an evidence of inaccuracy of the report, when it only evidences the thoughtlessness or unfairness of the critic.

It is true that the public want to know what these reports of early growth indicate. It may be proper to gratify this public anxiety, if it is understood that the expected result is subject to the limitations and contingencies of the future.

Any intelligent reader will perceive from the above that, so far as growth may indicate a harvest, 100 must point to different results in different districts. It may promise 35 bushels per acre in the Ohio Valley, or 15 on the Gulf coast. Each State must be considered separately, and all returns consolidated for an average of the whole field. This average, which has in some years been reported at 28 bushels for corn, would be less with a larger proportionate area in low-yielding districts, and larger with an increased proportion in the great corn-growing States. So it will be seen at once that a definite figure to represent 100 for corn, wheat, or any other crop, as a whole, cannot be made exact and unchangeable, on account of the changes in the territory represented and other circumstances producing variations in average yield. Yet there is no difficulty, if all these changing circumstances are considered, in finding the closely approximate indications of these figures of condition.

Another fact is obvious from the above, that 100 indicates more than an "average" crop. Corn in this country, in ten years past, has ranged from 18 to 30 bushels per acre in different years, with an average of 26. Wheat has averaged about 10 bushels in the worst season, and nearly 14 in the best, with an average for ten years a little above 12.

An average crop is the actual mean rate of yield in a series of years, which include some marked by 100 or more, and others by a much lower figure. Then, 100 means a *full* crop, not an *average* one.

Perhaps another difficulty may puzzle the brains of a reader of crop returns. He may wonder why July figures are so often higher than those of August, September, and October; sometimes higher than those of June. Then he may be surprised because some crops appear so generally to decline. This is apt to occur in cotton returns. It is simply because June and July are usually favorable to growth, while April and May, from frost or rain, may be unpropitious for planting and germination, and August and September are more liable to drought, subject to insect invasion, rust, and blight. The critical time, in which insects and disease make havoc, is just before maturity and fruitage. There

are other crops that have shorter seasons and fewer changes. Hay is soon made. If conditions are favorable on the first of June a drought must come speedily to affect the expected result. Corn that is well reported in July and August may be represented by 100 in October, or a long drought or a September frost may cut it down to 50. These explanations are so obvious as to seem unnecessary, yet there are repeated inquiries showing the necessity; and they are given here for the benefit of all who fail to understand the purport of the figures.

So much has been said of "condition." As the harvest approaches the result is asked by counties in plain figures—the yield per acre in bushels or pounds, the aggregate county product compared with the previous year, &c. At the time of seeding the area in each county is asked, 100 representing the number of acres harvested the previous year. Our system in its essential features is the one used by the most advanced nations in the world; it has been adopted by the State bureaus, and by a few newspapers that attempt to give really systematic crop returns. Its essential feature is the decimal system, which is becoming the cosmopolitan plan in weights and measures. It was first used by this Department in crop returns in 1864, upon the organization of its statistical work. It had previously been used in crop reporting by Mr. Orange Judd in the *American Agriculturist*, who was perhaps the first to use it in this country. It furnishes simply an opportunity for nicer discriminations than the old unsystematic and indefinite report of "half a crop," "a failure," or "serious damage," the intended meaning of which no one can put in positive figures. A reporter's deliberate judgment can certainly be presented far more accurately in decimals of a full crop.

The popularity of the crop reports is attested by the fact that nearly every newspaper, grain dealer, or speculator assumes to have original sources of crop information, in some cases with the least modicum of ground for the assumption. Pretentious estimates, detailed and specific, have gone the rounds of the metropolitan and country press unchallenged and apparently accepted, which have been copied from the Department estimates of *the previous year*, and made to do duty for the new crop as original information from trustworthy private sources. It would be well if the press were more discriminating, making distinction at least between well-digested and systematic efforts of legitimate newspapers in statistical collection and the multitude of charlatans and adventurers and tools of speculators. There is room for all legitimate work in crop statistics; and the best will be done with modesty and in the spirit of fairness and honesty.

CROP ESTIMATES OF 1883.

The principal products of last year were indicated with approximate nearness early in the season, and some of the principal were given in detail by States in the last report. At the close of each year the results of each month's returns are compared, and discrepancies involved in them duly examined and corrected, for publication as a permanent record of the year's harvests, with values, as well as prices and rates of yield. Their tabulations by States are given in the following pages.

CORN.

The area of this cereal was increased in 1883 over 3 per cent., from 65,650,546 to 68,301,889. This is an increase of 9 per cent. in four years

from the census enumeration. The largest extension of area is in the Missouri Valley, which is becoming a preferred region for corn culture.

The rainfall in the spring and early summer was unfavorable for planting and for germination of the seed, which was immature in many cases, being taken with too little care from fields that had been planted late. There were considerable areas in which early-planted fields had been invaded by frosts, making replanting necessary.

The average condition of corn in July was 88, or 12 per cent. below the normal standard, indicating a probable crop below the average. There was excess of rainfall in May in New England, on the Gulf coast, and in the Ohio Valley and Lower Lake regions, which interfered greatly with planting and growth. In the latter part of June improvement began to be noticeable, which was continued in July in New England, the Middle States, and Ohio Valley, and west of the Mississippi. In the South drought began to affect condition seriously. In Michigan there was an excess of moisture in August, which caused some retrograde in average condition.

The temperature of the season was too low for the best results. In the month of May, everywhere except in the Middle States and the northern plateau and North Pacific Coast, temperature was lower than the average. In the Missouri Valley the deficiency was 6°.9. In June the interior regions, from the Lakes to the Gulf, continued low, the deficiency being from 1° to 3°. In July temperature was low in all corn-growing regions, deficient from 1° to 5°. The deficiency was 4° in the lake region, and 2½° in the Missouri Valley in August, and nearly three in the Upper Mississippi Valley.

The want of seasonable rains began to be felt in midsummer, and became more serious later, reducing condition in most of the States east of the Mississippi, and in the Southwest, even more than the low temperature.

The effect of early frosts, in this state of the crop, were greatly feared. On the 8th and 9th of September the fields were stricken severely in the northern belt, the effects of which were thus described in the September report:

The injury caused by the frosts of the past week has been reported by telegraph from most of the territory affected. The injury is mainly in Northern Ohio, the northern portions of Indiana and Illinois, Michigan, Minnesota, and Dakota, and a belt of adjacent territory in Iowa and Nebraska. The Mississippi and Lake region was affected much more seriously than the Missouri Valley.

Agent Chamberlain reports for Ohio that "three frosts have killed nearly all corn foliage in Ohio; damage in north half very heavy, in south half light, except as to fodder. The per cent. of damage for the State is at least 20."

Agent Rinard reports for Indiana: "Some serious damage is reported from the northern division, ranging from 10 to 20 per cent. in some counties. Frost is not general in central division, damage about 5 per cent. in a few counties. There are no serious reports from the southern division."

Agent Fisher says the injury to corn in Illinois is confined to low grounds in the north third of the State, and that the damage in that section is about 15 per cent. of the promise on the 1st of September. The Minnesota agent, Mr. Young, reports that 50 per cent. of the corn of Minnesota is damaged.

Agent Baynes reports for Dakota that "the frost of the 8th appears to have fallen in spots, and in some localities corn is badly injured. The damage is slight; probably 20 per cent. of the corn in the Territory is injured."

The damage is great in Michigan and Wisconsin, especially serious on low lands where the plant was very immature. In New York and Northern Pennsylvania corn has been injured by frosts. The extent of injury to the general crop cannot be precisely determined at present, but may reduce the general average four points, which will mean four-fifths of a full crop, or about 23.2 bushels per acre. If the future should verify this estimate, the crop will aggregate 1,600,000,000 bushels in round numbers, or substantially the same as that of last year, though the soft corn, which was abundant last year, would be in larger proportion this year, and therefore of less intrinsic value.

This prediction was fully verified in the final record of the crop, which showed 1,551,066,895 bushels, and the rate of yield 22.7 bushels per acre, about 3 per cent. less than the indications reported by the Press Association within two days after the occurrence of the destructive frosts of September.

WHEAT.

There was a decrease of the wheat area harvested in 1883 of over 600,000 acres, though the April returns indicated a small enlargement of the breadth of winter wheat seeded in the fall. More than a million acres were either plowed up or abandoned as the returning spring revealed the injury done by frost.

Condition of winter wheat was lower than in 1881, and in May indicated a reduction in product of 77,000,000 bushels. The expectation was fully realized. The recorded estimates of the harvest of the two years were 504,185,470 and 421,086,160 bushels, respectively, though the yield of spring wheat was good and the area somewhat enlarged. The tendency in the spring-wheat region is towards decrease of breadth in the older settlements, and increase in the new lands. A decline in yield soon follows the imperfect cultivation and weeds of the pioneer wheat-fields. The production of wheat, winter and spring, was below an average, the rate of yield being 11.6 bushels per acre, on a reduced breadth. With a loss of 83,000,000 bushels, as compared with the previous crop, there was still nearly enough for consumption and exportation, leaving a large surplus by reason of the excess of old wheat of 1882 carried over.

OATS.

The substitution of spring oats for winter wheat helped to increase the area in this cereal, which is estimated at 20,324,962 acres, an increase of nearly two million acres. The season was much more favorable for oats than for wheat, and the yield per acre was fully as large as in 1882, while the product was larger by 83,000,000 bushels. The abundance had the effect to reduce the average price from 37.5 cents to 33 cents per bushel.

BARLEY.

This cereal, of which a supply is never grown in the States, was increased slightly in area, and produced at the rate of 21.1 bushels per acre, an aggregate as estimated of 50,136,097 bushels. The crop maintained a comparative high condition through the season.

RYE.

There was a small increase in the area of rye, from 2,227,880 to 2,314,754. The season was less favorable, and the rate of yield was reduced from 13.4 bushels to 12.1 per acre, and the product from 29,960,037 to 28,058,583 bushels. It was affected by conditions unfavorable for wheat, but to a less degree.

BUCKWHEAT.

This crop, which is grown mainly in the higher latitudes and late in the season, was affected disastrously by the frosts of September. The reduction in the product harvested was from 11,019,353 bushels in 1882 to 7,668,954 in 1883.

POTATOES.

The largest crop of potatoes ever grown in the United States was produced in 1883. With a small enlargement of area the yield advanced from 78 to 91 bushels per acre, making a product of 208,164,425 bushels, or thirty-eight millions in excess of the previous crop. The average yield per acre for a series of years, as estimated and recorded, is 84 bushels.

The effect of last year's abundance was to reduce the price from 57 cents for the previous crop to 42 cents.

HAY.

A marked increase of area in meadows was reported of over three millions of acres, and the conditions so unfavorable to wheat were especially advantageous to grass. The yield was therefore increased from 1.18 to 1.32 tons per acre and the product was the largest ever reported, 46,864,009 tons.

METEOROLOGICAL INFLUENCES OF THE SEASON.

As has been hinted above, there was a deficiency of heat for early maturity of maize in the belt of principal production, and for the development of other summer crops, and in some districts an excess of moisture in the planting season. The study of the influence of temperature and rainfall on production is important in explanation of the causes producing obvious results, and the following tables, compiled from Signal Service records, are presented for the purpose of facilitating such investigation.

Average rainfall, 1883.

Districts.	April.		May.		June.		July.		August.		September.	
	1883.	Series of years.	1883.	Series of years.	1883.	Series of years.	1883.	Series of years.	1883.	Series of years.	1883.	Series of years.
	In.	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
New England	2.78	3.79	4.77	3.36	3.36	3.60	5.76	3.92	1.53	4.33	2.50	3.74
Middle Atlantic States	4.54	3.50	2.38	2.96	5.22	3.52	3.28	4.04	3.20	4.05	4.47	4.14
South Atlantic States	6.50	4.57	6.13	3.22	6.49	4.57	4.92	5.65	7.51	6.43	6.63	5.94
Florida Peninsula	2.96	3.03	3.33	3.50	4.80	5.70	4.49	5.77	5.69	7.67	5.07	6.76
Eastern Gulf	8.30	5.54	4.37	4.40	4.91	4.29	2.50	5.04	4.39	6.33	1.05	4.98
Western Gulf	5.25	4.48	3.50	5.00	3.73	3.37	2.44	4.16	1.62	4.27	3.17	4.33
Rio Grande Valley	1.08	1.25	1.13	4.06	......	......	......	......	......	......	6.31	4.54
Tennessee	7.12	5.74	4.28	3.74	3.49	4.34	3.07	4.06	3.51	3.92	2.29	3.48
Ohio Valley	4.21	3.60	4.62	3.85	4.21	4.64	5.35	4.55	1.94	3.70	1.53	2.49
Lower Lakes	2.00	2.20	5.79	2.77	4.04	3.26	4.51	3.84	2.39	2.91	2.82	3.03
Upper Lakes	1.74	2.27	4.49	3.64	5.38	4.47	5.42	3.36	1.25	3.12	2.78	3.98
Extreme Northwest	1.26	1.67	1.68	3.33	2.50	4.10	2.44	2.83	2.70	2.50	1.01	2.24
Upper Mississippi Valley	3.50	2.90	5.17	4.49	5.98	5.82	5.58	4.02	1.87	3.40	1.67	3.45
Missouri Valley	3.17	2.91	7.43	4.40	7.98	5.06	3.37	4.44	2.52	2.81	2.60	2.60
Northern Slope	1.60	1.17	2.75	2.79	3.43	2.53	0.82	1.94	1.83	1.39	0.89	1.26
Middle Slope	1.96	1.18	4.43	3.34	2.27	2.01	2.57	2.77	3.65	1.42	3.02	1.59
Southern Slope	0.85	1.12	4.45	2.54	1.70	3.26	3.19	2.50	1.95	2.90	......	......
Northern Plateau	1.17	2.46	2.01	1.02	......	......	0.00	1.01	......	......	0.06	0.78
Middle Plateau	2.03	1.72	0.65	1.34	......	......	......	......	......	......	......	......
Southern Plateau	0.16	0.40	0.38	0.22	0.03	0.40	2.50	2.35	2.26	3.16	0.57	1.22
North Pacific	7.18	3.02	3.24	2.38	0.04	1.50	0.00	0.58	0.08	0.78	1.18	2.13
Middle Pacific	1.38	2.22	3.11	0.78	......	0.18	0.00	0.01	0.00	0.02	0.48	0.21
South Pacific	0.56	0.87	1.00	0.20	0.04	0.02	0.15	0.08	0.07	0.22	0.04	0.03
Mount Washington, N. H	6.21	4.18	9.10	6.39	11.30	8.53	11.14	7.43	6.06	7.67	6.90	9.09
P ke's Peak, Colo	1.68	3.87	2.80	4.27	1.76	1.94	5.37	4.89	2.22	4.81	1.76	2.11
Salt Lake City, Utah	......	......	......	......	0.33	0.75	0.10	0.68	0.62	0.88	0.13	0.81

Average temperature, 1883.

Districts.	April.		May.		June.		July.		August.		September.	
	1883.	Series of years.	1883.	Series of years.	1883.	Series of years.	1883.	Series of years.	1883.	Series of years.	1883.	Series of years.
	°	°	°	°	°	°	°	°	°	°	°	°
New England	43.5	43.2	54.8	55.1	66.7	64.4	69.0	69.8	68.1	69.5	59.8	62.2
Middle Atlantic States	50.1	50.6	61.5	61.4	71.7	70.5	75.3	75.6	72.3	73.8	65.8	68.2
South Atlantic States	61.7	62.0	68.9	70.0	78.2	77.8	81.5	80.4	78.2	79.3	72.8	74.3
Florida Peninsula	74.2	72.4	76.0	77.0	82.3	81.7	84.2	83.0	82.9	82.2	79.7	80.1
Eastern Gulf	66.3	65.5	70.6	73.3	79.0	79.4	81.8	81.2	79.5	79.6	75.2	74.8
Western Gulf	67.4	66.9	72.3	74.4	80.4	80.5	82.1	82.7	81.1	81.6	75.4	76.0
Rio Grande Valley	73.1	72.8	78.8	77.7	......	......	......	......	......	......	78.8	80.5
Tennessee	60.9	59.6	66.2	69.6	76.0	76.3	78.1	79.4	74.6	77.2	69.7	70.1
Ohio Valley	54.4	53.7	62.1	65.9	72.5	73.4	75.4	77.8	72.1	75.9	65.8	67.7
Lower Lakes	41.6	42.9	51.6	56.2	64.7	65.3	68.4	70.9	66.5	70.1	58.2	62.7
Upper Lakes	40.1	39.5	47.5	52.6	60.8	61.9	65.9	68.5	63.5	67.3	55.3	59.0
Extreme Northwest	38.5	37.3	47.6	54.1	62.4	61.6	65.5	68.7	62.7	66.3	53.7	54.7
Upper Mississippi Valley	52.3	50.9	57.8	63.9	69.3	71.6	74.1	76.1	70.2	74.6	61.6	64.8
Missouri Valley	50.8	48.2	55.5	62.4	68.3	72.0	73.7	76.0	70.9	75.1	60.4	63.6
Northern Slope	43.4	43.5	49.2	53.9	61.9	63.0	66.9	69.1	66.7	69.0	56.4	56.7
Middle Slope	50.7	51.6	58.5	60.6	69.0	72.3	73.6	73.7	72.9	72.5	63.9	63.9
Southern Slope	62.2	64.8	73.0	73.4	78.0	78.4	80.0	81.5	80.2	79.6	......	......
Northern Plateau	45.5	48.3	55.0	54.9	......	......	72.6	70.2	......	......	59.8	59.8
Middle Plateau	43.9	48.5	55.0	57.0	......	......	......	......	......	......	......	......
Southern Plateau	56.3	59.4	65.2	68.6	78.9	78.0	80.0	82.0	78.3	78.5	72.4	72.2
North Pacific	48.2	50.2	55.8	54.9	63.6	62.0	66.9	66.7	62.4	64.4	59.4	58.9
Middle Pacific	54.9	57.7	61.2	62.6	70.9	68.7	72.3	71.2	69.7	70.5	69.7	68.0
South Pacific	59.6	61.7	65.5	67.2	74.2	72.4	80.9	80.0	79.9	80.6	75.8	72.8
Mount Washington, N. H	20.0	20.6	34.0	33.5	46.6	43.4	46.4	48.0	43.8	47.5	38.9	40.9
Pike's Peak, Colo	12.1	13.1	19.5	22.5	31.3	33.3	39.1	40.4	38.8	39.0	30.2	31.3
Salt Lake City, Utah	......	......	......	......	70.5	68.7	75.9	76.4	76.4	74.4	69.3	64.4

CROP ESTIMATES FOR 1883.

Table showing the product of each principal crop of the several States named, the yield per acre, the total acreage, the average price in each State, and the value of each crop for 1883.

Products.	Quantity produced in 1883.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
MAINE.					
Indian corn .... bushels..	1, 062, 800	35.0	30, 367	$0 82	$871, 496
Wheat .... do....	614, 300	14.2	43, 263	1 40	860, 020
Rye .... do....	30, 712	12.5	2, 458	95	29, 176
Oats .... do....	2, 665, 000	31.5	84, 579	45	1, 199, 250
Barley .... do....	249, 856	23.0	10, 875	80	199, 885
Buckwheat .... do....	340, 080	16.7	20, 770	55	187, 044
Potatoes .... do....	8, 219, 296	116.0	70, 856	48	3, 945, 262
Tobacco .... pounds..	....	....	....	....	....
Hay .... tons..	1, 214, 033	1.12	1, 083, 958	10 50	12, 747, 357
Total	....	....	1, 347, 126	....	20, [illegible], 780
NEW HAMPSHIRE.					
Indian corn .... bushels..	1, 368, 500	36.0	38, 014	82	1, 122, 170
Wheat .... do....	181, 700	15.8	11, 500	1 38	250, 746
Rye .... do....	29, 767	9.1	3, 280	93	27, 683
Oats .... do....	1, 033, 000	34.8	29, 697	47	485, 510
Barley .... do....	74, 800	20.4	3, 672	81	60, 588
Buckwheat .... do....	74, 290	16.3	4, 558	62	46, 060
Potatoes .... do....	3, 489, 285	111.0	31, 435	43	1, 500, 393
Tobacco .... pounds..	145, 978	1, 364.0	107	13	18, 977
Hay .... tons..	597, 409	.99	603, 534	10 76	6, 428, 114
Total	....	....	725, 792	....	9, [illegible], 241

Table showing the product of each principal crop, &c., for **1883—Continued.**

Products.	Quantity produced in 1883.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
VERMONT.					
Indian corn.......bushels..	1, 817, 300	31. 0	58, 623	$0 75	$1, 435, 667
Wheat.......do....	353, 700	16. 4	21, 573	1 24	438, 588
Rye.......do....	87, 516	13. 8	6, 322	90	78, 764
Oats.......do....	3, 548, 600	34. 6	102, 505	44	1, 561, 384
Barley.......do....	279, 214	24. 8	11, 256	77	214, 995
Buckwheat.......do....	310, 583	17. 6	17, 685	62	192, 561
Potatoes.......do....	4, 708, 550	110. 0	42, 805	42	1, 977, 591
Tobacco.......pounds..	....	....	....	....	....
Hay.......tons..	1, 148, 100	1. 19	964, 790	9 60	11, 021, 760
Total.......	....	....	1, 225, 559	....	16, 921, 310
MASSACHUSETTS.					
Indian corn.......bushels..	2, 039, 100	35. 0	58, 262	80	1, 631, 280
Wheat.......do....	19, 700	16. 7	1, 180	1 45	28, 565
Rye.......do....	422, 419	15. 9	26, 638	82	346, 384
Oats.......do....	724, 000	31. 3	23, 098	49	354, 760
Barley.......do....	77, 572	23. 9	3, 248	82	63, 609
Buckwheat.......do....	62, 415	11. 2	5, 555	80	49, 932
Potatoes.......do....	4, 522, 080	120. 0	37, 684	56	2, 532, 365
Tobacco.......pounds..	4, 038, 278	1, 435. 0	2, 814	13. 2	533, 053
Hay.......tons..	766, 885	1. 23	623, 484	16 40	12, 576, 914
Total.......	....	....	781, 963	....	18, 116, 862
RHODE ISLAND.					
Indian corn.......bushels..	414, 300	32. 0	12, 947	85	352, 155
Wheat.......do....	460	15. 3	30	1 40	644
Rye.......do....	15, 837	11. 5	1, 372	83	13, 145
Oats.......do....	179, 100	30. 4	5, 882	48	85, 968
Barley.......do....	21, 266	26. 3	808	83	17, 651
Buckwheat.......do....	1, 204	9. 6	126	85	1, 023
Potatoes.......do....	845, 185	121. 0	6, 985	60	507, 111
Tobacco.......pounds..	....	....	....	....	....
Hay.......tons..	81, 708	1. 15	71, 050	16 50	1, 348, 182
Total.......	....	....	99, 200	....	2, 325, 879
CONNECTICUT.					
Indian corn.......bushels..	1, 710, 000	30. 0	57, 101	81	1, 385, 100
Wheat.......do....	34, 300	15. 8	2, 171	1 25	42, 875
Rye.......do....	441, 303	14. 6	30, 302	82	361, 868
Oats.......do....	1, 100, 700	29. 6	37, 141	48	528, 336
Barley.......do....	14, 344	22. 9	626	75	10, 758
Buckwheat.......do....	89, 206	8. 1	10, 977	82	73, 149
Potatoes.......do....	3, 625, 700	100. 0	36, 257	53	1, 921, 621
Tobacco.......pounds..	9, 576, 824	1, 176. 0	8, 145	13. 5	1, 292, 871
Hay.......tons..	625, 856	1. 10	568, 960	15 30	9, 575, 507
Total.......	....	....	751, 580	....	15, 192, 175
NEW YORK.					
Indian corn.......bushels..	17, 512, 700	23. 0	761, 423	73	12, 784, 271
Wheat.......do....	8, 035, 200	10. 3	780, 124	1 11	8, 919, 072
Rye.......do....	2, 703, 816	11. 2	241, 685	72	1, 946, 748
Oats.......do....	42, 071, 400	31. 3	1, 344, 637	40	16, 828, 560
Barley.......do....	8, 649, 218	24. 2	357, 662	75	6, 486, 91[illegible]
Buckwheat.......do....	2, 360, 634	8. 1	290, 896	86	2, 030, 145
Potatoes.......do....	38, 472, 768	96. 0	400, 758	39	15, 004, 380
Tobacco.......pounds..	9, 068, 789	1, 667. 0	5, 440	13	1, 178, 943
Hay.......tons..	6, 058, 833	1. 22	4, 962, 158	10 50	63, 565, 247
Total.......	....	....	9, 144, 783	....	128, 744, 279
NEW JERSEY.					
Indian corn.......bushels..	9, 715, 100	28. 0	346, 971	65	6, 314, 815
Wheat.......do....	2, 0[illegible]3, 600	13. 4	154, 000	1 10	2, 269, 960
Rye.......do....	1, 028, 976	10. 1	101, 488	75	771, 732
Oats.......do....	4, 265, 800	32. 6	130, 873	40	1, 706, 320
Barley.......do....	4, 198	16. 9	249	76	3, 190
Buckwheat.......do....	244, 608	7. 0	35, 026	90	220, 147
Potatoes.......do....	4, 275, 857	97. 0	44, 081	55	2, 351, 721
Tobacco.......pounds..	....	....	....	....	....
Hay.......tons..	610, 751	1. 20	508, 959	13 75	8, 397, 826
Total.......	....	....	1, 321, 647	....	22, 035, 711

Table showing the product of each principal crop, &c., for 1883—Continued.

Articles.	Quantity produced in 1883.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
PENNSYLVANIA.					
Indian corn .... bushels..	37, 857, 400	27. 0	1, 402, 127	$0 67	$25, 364, 458
Wheat .... do....	20, 043, 800	13. 2	1, 518, 474	1 08	21, 647, 304
Rye .... do....	4, 049, 595	10. 1	402, 219	70	2, 834, 716
Oats .... do....	38, 193, 200	30. 6	1, 247, 868	40	15, 277, 280
Barley .... do....	578, 496	21. 0	27, 556	73	422, 302
Buckwheat .... do....	2, 467, 233	9. 8	251, 369	85	2, 097, 148
Potatoes .... do....	16, 185, 440	80. 0	202, 318	45	7, 283, 448
Tobacco .... pounds..	36, 322, 099	1, 258. 0	28, 879	12	4, 358, 652
Hay .... tons..	3, 286, 286	1. 20	2, 738, 572	10 45	34, 341, 689
Total	....	....	7, 819, 382	....	113, 626, 997
DELAWARE.					
Indian corn .... bushels..	3, 822, 200	18. 0	212, 346	50	1, 011, 100
Wheat .... do....	966, 700	10. 3	93, 860	1 11	1, 073, 037
Rye .... do....	6, 669	7. 9	840	60	4, 001
Oats .... do....	517, 600	23. 9	21, 664	40	207, 040
Barley .... do....	....	....	....	....	....
Buckwheat .... do....	6, 515	15. 2	428	75	4, 886
Potatoes .... do....	292, 810	70. 0	4, 183	47	137, 621
Tobacco .... pounds..	....	....	....	....	....
Hay .... tons..	56, 513	1. 15	49, 142	13 00	734, 669
Total	....	....	382, 463	....	4, 072, 354
MARYLAND.					
Indian corn .... bushels..	16, 251, 200	23. 5	691, 542	51	8, 288, 112
Wheat .... do....	7, 577, 000	12. 1	626, 200	1 06	8, 031, 620
Rye .... do....	314, 640	11. 3	27, 899	62	195, 077
Oats .... do....	2, 023, 800	20. 2	100, 323	39	789, 282
Barley .... do....	6, 514	26. 4	247	75	4, 885
Buckwheat .... do....	117, 800	11. 1	10, 573	80	94, 240
Potatoes .... do....	1, 656, 564	78. 0	21, 238	45	745, 454
Tobacco .... pounds..	31, 570, 793	778. 0	40, 598	06. 5	2, 052, 102
Hay .... tons..	343, 626	1. 20	286, 355	13 20	4, 535, 863
Total	....	....	1, 804, 970	....	24, 736, 695
VIRGINIA.					
Indian corn .... bushels..	26, 868, 700	14. 0	1, 919, 199	66	16, 121, 220
Wheat .... do....	8, 352, 800	9. 0	928, 089	1 05	8, 770, 440
Rye .... do....	324, 368	6. 4	50, 335	75	243, 276
Oats .... do....	6, 275, 600	10. 0	628, 434	47	2, 949, 532
Barley .... do....	18, 600	15. 4	1, 211	80	14, 880
Buckwheat .... do....	169, 065	10. 0	16, 925	78	131, 871
Potatoes .... do....	2, 443, 428	69. 0	35, 412	60	1, 466, 057
Tobacco .... pounds..	67, 865, 972	522. 0	129, 996	08	5, 429, 278
Hay .... tons..	335, 894	1. 18	284, 656	11 70	3, 929, 960
Cotton .... bales..	17, 300	. 31	55, 786	42 50	735, 250
Total	....	....	4, 050, 043	....	39, 791, 764
NORTH CAROLINA.					
Indian corn .... bushels..	28, 692, 200	11. 5	2, 494, 977	65	18, 649, 930
Wheat .... do....	4, 230, 800	5. 9	717, 100	1 17	4, 950, 036
Rye .... do....	394, 274	6. 1	64, 266	82	323, 306
Oats .... do....	5, 142, 000	8. 7	593, 890	51	2, 622, 420
Barley .... do....	2, 677	10. 1	265	80	2, 142
Buckwheat .... do....	49, 036	8. 2	5, 953	75	36, 777
Potatoes .... do....	1, 312, 935	65. 0	20, 199	68	892, 796
Tobacco .... pounds..	29, 048, 213	484. 0	60, 000	12. 5	3, 631, 027
Hay .... tons..	96, 434	1. 15	83, 856	10 77	1, 038, 594
Cotton .... bales..	398, 200	. 38	1, 050, 543	43 50	17, 321, 700
Total	....	....	5, 091, 049	....	49, 468, 727
SOUTH CAROLINA.					
Indian corn .... bushels..	11, 107, 800	8. 0	1, 388, 481	73	8, 108, 694
Wheat .... do....	1, 136, 200	5. 2	218, 500	1 30	1, 477, 060
Rye .... do....	32, 832	4. 1	8, 044	1 25	41, 040
Oats .... do....	3, 544, 000	9. 8	362, 805	63	2, 232, 720
Barley .... do....	18, 223	14. 9	1, 224	90	16, 401
Buckwheat .... do....	....	....	....	....	....
Potatoes .... do....	179, 100	50. 0	3, 582	85	152, 235
Tobacco .... pounds..	....	....	....	....	....
Hay .... tons..	3, 050	1. 00	3, 050	13 00	39, 650
Cotton .... bales..	469, 600	. 29	1, 618, 989	44 00	20, 662, 400
Total	....	....	3, 604, 675	....	32, 730, 298

Table showing the products of each principal crop, &c., for 1883—Continued.

Products.	Quantity produced in 1883.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
GEORGIA.					
Indian corn .... bushels..	24,615,000	8.7	2,829,415	$0 67	$16,492,653
Wheat .... do....	2,574,000	5.1	504,900	1 20	3,089,890
Rye .... do....	142,560	5.4	26,554	1 16	165,370
Oats .... do....	7,018,700	9.0	780,682	56	3,930,472
Barley .... do....	23,023	13.8	1,666	1 00	23,023
Buckwheat .... do....	....	....	....	....	....
Potatoes .... do....	565,348	61.0	9,268	86	486,199
Tobacco .... pounds..	....	....	....	....	....
Hay .... tons..	18,700	1.20	15,583	13 50	252,450
Cotton .... bales..	752,500	.26	2,872,748	44 00	33,110,000
Total	....	....	7,040,816	....	57,550,047
FLORIDA.					
Indian corn .... bushels..	3,399,200	8.5	399,914	82	2,787,344
Wheat .... do....	....	....	....	....	....
Rye .... do....	3,595	4.9	737	1 30	4,678
Oats .... do....	504,500	9.8	51,528	79	398,555
Barley .... do....	....	....	....	....	....
Buckwheat .... do....	....	....	....	....	....
Potatoes .... do....	159,808	88.0	1,816	90	143,827
Tobacco .... pounds..	....	....	....	....	....
Hay .... tons..	283	1.23	230	13 00	3,679
Cotton .... bales..	58,900	.23	257,799	45 00	2,650,500
Total	....	....	712,024	....	5,988,578
ALABAMA.					
Indian corn .... bushels..	26,189,300	11.5	2,277,338	64	16,761,152
Wheat .... do....	1,437,500	5.2	276,450	1 15	1,653,125
Rye .... do....	32,203	5.4	5,999	1 20	38,644
Oats .... do....	4,517,300	10.6	427,199	57	2,574,861
Barley .... do....	6,739	10.6	636	1 00	6,739
Buckwheat .... do....	....	....	....	....	....
Potatoes .... do....	587,598	66.0	8,903	90	528,938
Tobacco .... pounds..	....	....	....	....	....
Hay .... tons..	14,712	1.30	11,317	14 25	209,656
Cotton .... bales..	630,400	.24	2,610,420	44 50	28,082,800
Total	....	....	5,618,262	....	49,825,805
MISSISSIPPI.					
Indian corn .... bushels..	25,257,100	13.5	1,870,902	63	15,911,973
Wheat .... do....	247,500	5.0	49,500	1 20	297,000
Rye .... do....	5,347	6.0	884	1 30	6,951
Oats .... do....	3,142,400	11.5	374,236	60	1,885,440
Barley .... do....	....	....	....	....	....
Buckwheat .... do....	....	....	....	....	....
Potatoes .... do....	518,049	63.0	8,223	85	440,342
Tobacco .... pounds..	....	....	....	....	....
Hay .... tons..	13,643	1.35	10,106	14 00	191,002
Cotton .... bales..	901,300	.40	2,278,521	44 00	39,657,200
Total	....	....	4,592,372	....	58,389,908
LOUISIANA.					
Indian corn .... bushels..	13,130,600	14.2	924,693	0 66	8,666,196
Wheat .... do....	....	....	....	....	....
Rye .... do....	7,680	6.3	1,224	1 35	10 368
Oats .... do....	475,000	13.9	34,096	65	308,750
Barley .... do....	....	....	....	....	....
Buckwheat .... do....	....	....	....	....	....
Potatoes .... do....	449,625	75.0	5,995	80	359,700
Tobacco .... pounds..	....	....	....	....	....
Hay .... tons..	41,209	1.35	30,525	13 25	546,019
Cotton .... bales..	490,200	.53	931,900	44 00	21,568,800
Total	....	....	1,928,433	....	31,459,833
TEXAS.					
Indian corn .... bushels..	63,146,300	17.5	3,608,362	60	37,887,780
Wheat .... do....	4,301,000	8.5	506,000	1 00	4,301,000
Rye .... do....	57,855	11.5	5,040	1 05	60,748
Oats .... do....	9,489,300	22.8	416,096	51	4,839,543
Barley .... do....	127,030	17.0	7,463	75	95,272

Table showing the product of each principal crop, &c., for 1883—Continued.

Products.	Quantity produced in 1883.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
TEXAS—Continued.					
Buckwheat .... bushels..	....	....	....	....	....
Potatoes .... do	492,900	60.0	8,215	$0 90	$443,610
Tobacco .... pounds..	....	....	....	....	....
Hay .... tons..	107,249	1.38	77,717	10 60	1,136,839
Cotton .... bales..	1,118,000	.37	3,034,922	44 00	49,192,000
Total	....	....	7,663,815	....	97,956,792
ARKANSAS.					
Indian corn .... bushels..	30,456,500	17.5	1,740,372	53	16,141,945
Wheat .... do	1,416,400	6.1	232,200	1 03	1,458,892
Rye .... do	27,027	6.1	4,419	95	25,676
Oats .... do	3,225,400	14.4	223,961	50	1,612,700
Barley .... do	....	....	....	....	....
Buckwheat .... do	....	....	....	....	....
Potatoes .... do	717,278	62.0	11,569	72	516,440
Tobacco .... pounds..	1,100,000	478.0	2,300	8.7	95,700
Hay .... tons..	36,385	1.40	25,989	10 75	391,139
Cotton .... bales..	518,500	.44	1,188,545	44 00	22,814,000
Total	....	....	3,429,355	....	43,056,492
TENNESSEE.					
Indian corn .... bushels..	64,259,000	20.0	3,212,952	44	28,273,960
Wheat .... do	7,408,800	5.6	1,323,000	92	6,816,096
Rye .... do	190,190	5.3	35,779	73	138,839
Oats .... do	6,997,700	11.9	586,490	38	2,659,126
Barley .... do	45,490	14.6	3,112	71	32,298
Buckwheat .... do	29,674	5.5	5,357	72	21,365
Potatoes .... do	2,404,647	63.0	38,169	43	1,033,998
Tobacco .... pounds..	28,538,602	710.0	40,221	06	1,712,316
Hay .... tons..	244,843	1.30	188,341	10 00	2,448,430
Cotton .... bales..	310,700	.38	807,602	43 00	13,360,100
Total	....	....	6,241,023	....	56,496,528
WEST VIRGINIA.					
Indian corn .... bushels..	14,294,000	24.3	588,233	53	7,575,820
Wheat .... do	4,257,000	10.0	425,700	1 08	4,597,560
Rye .... do	149,985	8.6	17,410	75	112,489
Oats .... do	2,020,300	15.6	129,829	40	808,120
Barley .... do	11,731	20.9	561	80	9,385
Buckwheat .... do	226,200	7.0	32,451	80	180,960
Potatoes .... do	2,264,958	87.0	26,034	47	1,064,530
Tobacco .... pounds..	1,952,872	475.0	4,108	10.5	205,052
Hay .... tons..	279,124	1.20	232,603	8 40	2,344,642
Total	....	....	1,456,929	....	16,898,558
KENTUCKY.					
Indian corn .... bushels..	78,201,800	24.0	3,258,410	42	32,844,756
Wheat .... do	9,612,600	7.7	1,248,390	95	9,131,970
Rye .... do	795,104	7.8	90,787	68	479,471
Oats .... do	6,899,900	16.3	422,628	37	2,552,963
Barley .... do	450,468	22.1	20,390	69	310,823
Buckwheat .... do	11,353	9.4	1,213	90	10,218
Potatoes .... do	4,255,600	80.0	53,195	43	1,829,908
Tobacco .... pounds..	171,059,155	743.0	230,116	8.6	14,711,087
Hay .... tons..	270,738	1.30	208,260	9 75	2,639,696
Total	....	....	5,533,389	....	64,510,892
OHIO.					
Indian corn .... bushels..	73,560,000	26.1	2,818,480	47	34,573,200
Wheat .... do	25,884,000	10.0	2,588,400	99	25,625,160
Rye .... do	282,240	9.0	31,245	60	169,344
Oats .... do	29,560,000	33.9	871,250	35	10,346,000
Barley .... do	938,441	16.0	58,562	75	703,831
Buckwheat .... do	180,804	8.3	21,891	90	162,724
Potatoes .... do	16,452,315	99.0	166,185	40	6,580,926
Tobacco .... pounds..	29,947,536	932.0	32,128	08	2,395,803
Hay .... tons..	3,220,342	1.40	2,300,244	9 50	30,593,249
Total	....	....	8,888,385	....	111,150,237

Table showing the product of each principal crop, &c., for 1883—Continued.

Products.	Quantity produced in 1883.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
MICHIGAN.					
Indian corn........bushels..	21,412,300	23.5	911,165	$0 52	$11,134,396
Wheat........do....	25,011,000	14.0	1,786,500	96	24,010,560
Rye........do....	221,705	9.9	22,355	62	137,457
Oats........do....	20,061,300	34.6	580,451	35	7,021,455
Barley........do....	1,079,136	21.0	51,371	65	701,438
Buckwheat........do....	244,858	7.5	32,834	86	210,578
Potatoes........do....	11,811,979	83.0	142,313	41	4,842,911
Tobacco........pounds..	....	....	....	....	....
Hay........tons..	1,767,641	1.38	1,280,899	9 30	16,439,061
Total........	....	....	4,807,888	....	64,497,856
INDIANA.					
Indian corn........bushels..	95,620,000	27.0	3,541,482	41	39,204,200
Wheat........do....	28,447,800	10.4	2,735,370	95	27,025,410
Rye........do....	250,743	9.9	25,258	65	162,983
Oats........do....	21,304,100	29.7	717,560	32	6,817,312
Barley........do....	340,956	21.6	15,792	55	187,526
Buckwheat........do....	70,784	8.7	8,158	90	63,706
Potatoes........do....	8,477,010	90.0	94,189	33	2,797,413
Tobacco........pounds..	8,471,240	714.0	11,863	7.5	635,343
Hay........tons..	1,876,595	1.46	1,285,339	8 50	15,951,058
Total........	....	....	8,435,011	....	92,844,951
ILLINOIS.					
Indian corn........bushels..	203,786,500	25.0	8,151,463	40	81,514,600
Wheat........do....	22,150,000	10.0	2,215,000	92	20,378,000
Rye........do....	5,099,640	15.7	324,870	54	2,753,806
Oats........do....	102,780,000	36.1	2,848,555	27	27,750,600
Barley........do....	876,525	20.1	43,520	55	482,089
Buckwheat........do....	114,019	6.8	16,672	89	101,477
Potatoes........do....	12,978,440	92.0	141,070	36	4,672,238
Tobacco........pounds..	3,155,462	556.0	5,679	08	252,437
Hay........tons..	4,270,062	1.45	2,944,870	7 25	30,957,950
Total........	....	....	16,691,699	....	168,863,197
WISCONSIN.					
Indian corn........bushels..	23,579,300	21.0	1,122,826	48	11,318,064
Wheat........do....	19,604,900	12.3	1,593,900	88	17,252,312
Rye........do....	2,396,530	14.0	170,998	50	1,198,265
Oats........do....	40,502,700	30.4	1,331,392	31	12,555,837
Barley........do....	6,061,272	24.1	251,688	55	3,333,700
Buckwheat........do....	177,792	5.5	32,171	75	133,344
Potatoes........do....	10,127,912	92.0	110,086	33	3,342,211
Tobacco........pounds..	5,743,828	450.0	12,750	11	631,821
Hay........tons..	2,354,835	1.40	1,682,025	7 00	16,483,845
Total........	....	....	6,307,836	....	66,249,399
MINNESOTA.					
Indian corn........bushels..	15,124,800	20.8	727,155	43	6,503,664
Wheat........do....	33,773,200	13.0	2,597,940	80	27,018,560
Rye........do....	466,867	14.8	31,440	50	233,434
Oats........do....	31,447,500	33.1	949,200	28	8,805,300
Barley........do....	7,276,040	22.9	318,270	47	3,419,739
Buckwheat........do....	30,360	5.3	5,772	73	22,163
Potatoes........do....	5,839,000	100.0	58,390	27	1,576,530
Tobacco........pounds..	....	....	....	....	....
Hay........tons..	2,054,888	1.35	1,522,139	4 50	9,246,996
Total........	....	....	6,210,306	....	56,826,386
IOWA.					
Indian corn........bushels..	169,629,000	24.3	6,980,621	32	54,281,280
Wheat........do....	27,518,800	11.3	2,435,300	80	22,015,040
Rye........do....	1,463,076	11.9	122,522	43	629,123
Oats........do....	68,403,600	34.1	2,005,569	26	17,784,936
Barley........do....	4,638,348	21.9	211,428	45	2,087,257
Buckwheat........do....	135,270	8.0	17,014	80	108,216
Potatoes........do....	13,216,868	98.0	134,866	28	3,700,723
Tobacco........pounds..	....	....	....	....	....
Hay........tons..	4,372,849	1.30	3,363,730	4 50	19,677,821
Total........	....	....	15,271,050	....	120,284,396

Table showing the product of each principal crop, &c., for 1883—Continued.

Products.	Quantity produced in 1883.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
MISSOURI.					
Indian corn........bushels..	161,655,000	27.5	5,878,364	$0 35	$56,579,250
Wheat........do....	23,819,300	10.1	2,358,350	88	20,960,984
Rye........do....	570,851	11.2	51,076	55	313,968
Oats........do....	30,374,200	28.7	1,057,422	25	7,593,550
Barley........do....	179,982	22.3	8,080	50	89,991
Buckwheat........do....	63,756	11.1	5,728	75	47,817
Potatoes........do....	6,535,570	86.0	75,995	40	2,614,228
Tobacco........pounds..	10,540,000	684.0	15,400	08.5	895,900
Hay........tons..	1,400,021	1.25	1,120,017	6 50	9,100,137
Total........	....	....	10,570,432	....	98,195,825
KANSAS.					
Indian corn........bushels..	172,800,900	36.7	4,708,473	26	44,928,234
Wheat........do....	26,851,100	17.5	1,534,350	78	20,943,858
Rye........do....	4,583,500	17.0	269,280	37	1,696,895
Oats........do....	27,560,000	39.4	699,476	21	5,787,600
Barley........do....	347,490	18.5	18,794	40	138,996
Buckwheat........do....	27,720	9.2	2,999	84	23,285
Potatoes........do....	6,361,520	80.0	79,519	52	3,307,990
Tobacco........pounds..	....	....	....	....	....
Hay........tons..	5,075,000	1.45	3,500,000	3 75	19,031,250
Total........	....	....	10,812,891	....	95,857,108
NEBRASKA.					
Indian corn........bushels..	101,278,900	36.0	2,813,303	34	34,306,836
Wheat........do....	27,481,300	15.5	1,772,990	70	19,236,910
Rye........do....	1,026,080	16.0	64,176	35	359,128
Oats........do....	21,630,000	40.0	540,161	20	4,326,000
Barley........do....	3,623,880	22.1	163,800	37	1,340,836
Buckwheat........do....	20,808	10.3	2,029	80	16,646
Potatoes........do....	3,467,124	82.0	42,282	30	1,040,137
Tobacco........pounds..	....	....	....	....	....
Hay........tons..	1,123,601	1.50	749,067	3 50	3,932,604
Total........	....	....	6,147,808	....	54,558,197
CALIFORNIA.					
Indian corn........bushels..	2,464,800	24.5	100,607	85	2,095,080
Wheat........do....	36,322,000	13.0	2,794,000	1 00	36,322,000
Rye........do....	209,587	7.0	29,813	95	199,108
Oats........do....	1,826,600	25.8	70,858	58	1,059,428
Barley........do....	10,135,854	16.2	625,498	63	6,385,588
Buckwheat........do....	25,806	22.2	1,161	90	23,225
Potatoes........do....	4,440,906	81.0	54,826	60	2,664,544
Tobacco........pounds..	....	....	....	....	....
Hay........tons..	1,307,045	1.50	871,363	12 50	16,338,063
Total........	....	....	4,548,126	....	65,087,036
OREGON.					
Indian corn........bushels..	129,300	23.5	5,504	75	96,975
Wheat........do....	18,122,400	16.5	795,300	90	11,810,160
Rye........do....	19,026	14.5	1,312	85	16,172
Oats........do....	4,211,800	24.6	170,993	53	2,232,254
Barley........do....	885,060	26.9	32,857	65	575,289
Buckwheat........do....	8,150	16.0	510	90	7,335
Potatoes........do....	941,120	80.0	11,764	70	658,784
Tobacco........pounds..	....	....	....	....	....
Hay........tons..	315,210	1.55	203,361	12 75	4,018,928
Total........	....	....	1,221,601	....	19,415,897
NEVADA.					
Indian corn........bushels..	21,100	24.9	847	40	8,440
Wheat........do....	99,200	18.3	5,424	1 10	109,120
Rye........do....	....	....	....	....	....
Oats........do....	212,100	28.9	7,341	60	127,260
Barley........do....	458,640	20.6	22,270	80	366,912
Buckwheat........do....	....	....	....	....	....
Potatoes........do....	415,815	95.0	4,377	75	311,861
Tobacco........pounds..	....	....	....	....	....
Hay........tons..	129,487	1.55	83,540	13 25	1,715,703
Total........	....	....	123,803	....	2,639,296

Table showing the product of each principal crop, &c., for 1883—Continued.

Products.	Quantity produced in 1883.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
COLORADO.					
Indian corn .... bushels..	532, 100	25. 0	21, 287	$0 85	$452, 285
Wheat .... do....	2, 394, 000	21. 0	114, 000	96	2, 298, 240
Rye .... do....	31, 046	17. 4	1, 783	80	24, 837
Oats .... do....	1, 209, 000	29. 3	41, 250	60	725, 400
Barley .... do....	157, 080	25. 9	6, 064	75	117, 810
Buckwheat .... do....	....	....	....	....	....
Potatoes .... do....	506, 515	85. 0	5, 959	65	329, 235
Tobacco .... pounds..	....	....	....	....	....
Hay .... tons..	114, 505	1. 40	81, 789	13 50	1, 545, 818
Total	....	....	272, 132	....	5, 493, 625
ARIZONA.					
Indian corn .... bushels..	54, 700	20. 0	2, 736	86	47, 042
Wheat .... do....	222, 200	14. 0	15, 810	1 05	233, 310
Rye .... do....	....	....	....	....	....
Oats .... do....	6, 000	25. 0	240	62	3, 720
Barley .... do....	330, 775	18. 7	17, 713	73	241, 466
Buckwheat .... do....	....	....	....	....	....
Potatoes .... do....	52, 936	52. 0	1, 018	80	42, 349
Tobacco .... pounds..	....	....	....	....	....
Hay .... tons..	10, 710	. 85	12, 600	13 00	139, 230
Total	....	....	50, 117	....	707, 117
DAKOTA.					
Indian corn .... bushels..	4, 915, 055	18. 2	270, 058	45	2, 211, 775
Wheat .... do....	16, 128, 000	16. 0	1, 008, 000	72	11, 612, 160
Rye .... do....	174, 167	21. 7	8, 014	55	95, 792
Oats .... do....	9, 000, 000	42. 9	210, 000	28	2, 520, 000
Barley .... do....	731, 013	23. 5	31, 100	40	292, 405
Buckwheat .... do....	2, 931	5. 3	553	90	2, 638
Potatoes .... do....	1, 265, 355	103. 0	12, 285	30	379, 607
Tobacco .... pounds..	....	....	....	....	....
Hay .... tons..	585, 200	1. 40	418, 000	3 75	2, 194, 500
Total	....	....	1, 958, 010	....	19, 308, 877
IDAHO.					
Indian corn .... bushels..	32, 500	20. 0	1, 627	90	29, 250
Wheat .... do....	682, 500	15. 3	44, 687	90	614, 250
Rye .... do....	13, 294	13. 1	1, 013	90	11, 965
Oats .... do....	1, 140, 000	37. 4	30, 450	57	649, 800
Barley .... do....	339, 591	28. 4	11, 977	75	254, 603
Buckwheat .... do....	....	....	....	....	....
Potatoes .... do....	269, 280	102. 0	2, 640	72	193, 882
Tobacco .... pounds..	....	....	....	....	....
Hay .... tons..	65, 520	1. 30	50, 400	8 00	524, 160
Total	....	....	142, 794	....	2, 27[illegible], 000
MONTANA.					
Indian corn .... bushels..	10, 040	20. 0	502	90	9, 036
Wheat .... do....	942, 000	16. 3	57, 796	92	866, 640
Rye .... do....	....	....	....	....	....
Oats .... do....	1, 210, 000	37. 6	32, 200	58	701, 800
Barley .... do....	50, 182	25. 8	1, 945	73	36, 633
Buckwheat .... do....	....	....	....	....	....
Potatoes .... do....	270, 375	105. 0	2, 575	70	189, 263
Tobacco .... pounds..	....	....	....	....	....
Hay .... tons..	110, 664	1. 20	92, 220	10 50	1, 161, 972
Total	....	....	187, 238	....	2, 965, 344
NEW MEXICO.					
Indian corn .... bushels..	930, 100	20. 0	46, 506	83	771, 983
Wheat .... do....	977, 900	15. 0	65, 193	1 05	1, 026, 795
Rye .... do....	....	....	....	....	....
Oats .... do....	199, 800	17. 0	11, 760	60	119, 880
Barley .... do....	58, 913	20. 4	2, 887	80	47, 130
Buckwheat .... do....	....	....	....	....	....
Potatoes .... do....	32, 120	70. 0	450	1 00	32, 130
Tobacco .... pounds..	....	....	....	....	....
Hay .... tons..	13, 860	1. 20	11, 550	11 00	152, 460
Total	....	....	138, 355	....	2, 150, 378

Table showing the products of each principal crop, &c., for 1883—**Continued.**

Products.	Quantity produced in 1883.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
UTAH.					
Indian corn.......bushels..	280, 100	21. 0	13, 840	$0 88	$246, 488
Wheat.......do....	1, 579, 400	19. 0	83, 130	92	1, 453, 048
Rye.......do....	22, 821	10. 3	2, 220	80	18, 257
Oats.......do....	546, 000	22. 7	24, 050	57	311, 220
Barley.......do....	296, 396	24. 5	12, 114	67	198, 585
Buckwheat.......do....	....	....	....	....	....
Potatoes.......do....	949, 416	104. 0	9, 129	72	683, 580
Tobacco.......pounds..	....	....	....	....	....
Hay.......tons..	174, 720	1. 40	124, 800	3 60	628, 992
Total.......	....	....	268, 783	....	3, 540, 170
WASHINGTON.					
Indian corn.......bushels..	61, 400	23. 0	2, 672	90	55, 260
Wheat.......do....	3, 182, 700	18. 7	170, 200	85	2, 705, 295
Rye.......do....	23, 139	16. 6	1, 398	90	20, 825
Oats.......do....	2, 480, 400	39. 7	63, 540	55	1, 364, 220
Barley.......do....	671, 064	32. 7	20, 552	63	422, 770
Buckwheat.......do....	....	....	....	....	....
Potatoes.......do....	1, 003, 530	110. 0	9, 123	55	551, 943
Tobacco.......pounds..	....	....	....	....	....
Hay.......tons..	252, 450	1. 50	168, 300	13 00	3, 281, 850
Total.......	....	....	434, 785	....	8, 402, 163
WYOMING.					
Indian corn.......bushels..	....	....	....	....	....
Wheat.......do....	26, 500	15. 2	1, 747	98	25, 970
Rye.......do....	....	....	....	....	....
Oats.......do....	63, 000	30. 0	2, 100	60	37, 800
Barley.......do....	....	....	....	....	....
Buckwheat.......do....	....	....	....	....	....
Potatoes.......do....	104, 500	100. 0	1, 045	68	71, 060
Tobacco.......pounds..	....	....	....	....	....
Hay.......tons..	21, 450	1. 30	16, 500	13 00	278, 850
Total.......	....	....	21, 392	....	413, 680

Summary for each State, showing the product, the area, and the value of each crop named, for 1883.

States and Territories.	Corn.			Wheat.		
	Bushels.	Acres.	Value.	Bushels.	Acres.	Value.
Maine.......	1, 062, 800	30, 367	$871, 496	614, 300	43, 263	860, 020
New Hampshire.......	1, 368, 500	38, 014	1, 122, 170	181, 700	11, 500	250, 746
Vermont.......	1, 817, 300	58, 623	1, 435, 667	353, 700	21, 573	438, 588
Massachusetts.......	2, 0391100	58, 262	1, 631, 280	19, 700	1, 160	28, 565
Rhode Island.......	414, 300	12, 947	352, 155	460	30	644
Connecticut.......	1, 710, 000	57, 001	1, 385, 100	34, 300	2, 171	42, 875
New York.......	17, 512, 700	761, 423	12, 784, 271	8, 035, 200	780, 124	8, 919, 072
New Jersey.......	9, 715, 100	346, 971	6, 314, 815	2, 063, 600	154, 000	2, 269, 960
Pennsylvania.......	37, 857, 400	1, 402, 127	25, 364, 458	20, 043, 800	1, 518, 474	21, 647, 304
Delaware.......	3, 822, 200	212, 346	1, 911, 100	966, 700	93, 860	1, 073, 037
Maryland.......	16, 251, 200	691, 542	8, 288, 112	7, 577, 000	626, 200	8, 031, 620
Virginia.......	26, 868, 700	1, 919, 199	16, 121, 220	8, 352, 800	928, 089	8, 770, 440
North Carolina.......	28, 692, 200	2, 494, 977	18, 649, 930	4, 230, 800	717, 100	4, 950, 036
South Carolina.......	11, 107, 800	1, 388, 481	8, 108, 694	1, 136, 200	218, 500	1, 477, 060
Georgia.......	24, 615, 900	2, 829, 415	16, 492, 653	2, 574, 900	504, 900	3, 089, 880
Florida.......	3, 399, 200	399, 914	2, 787, 344	....	....	....
Alabama.......	26, 189, 300	2, 277, 338	16, 761, 152	1, 437, 500	276, 450	1, 653, 125
Mississippi.......	25, 257, 100	1, 870, 902	15, 911, 973	247, 500	49, 500	297, 000
Louisiana.......	13, 130, 600	924, 693	8, 666, 196	....	....	....
Texas.......	63, 146, 300	3, 608, 362	37, 887, 780	4, 301, 000	506, 000	4, 301, 000
Arkansas.......	30, 456, 500	1, 740, 372	16, 141, 945	1, 416, 400	232, 200	1, 458, 892
Tennessee.......	64, 259, 000	3, 212, 952	28, 273, 960	7, 408, 800	1, 323, 000	6, 816, 096
West Virginia.......	14, 294, 000	588, 233	7, 575, 820	4, 257, 000	425, 700	4, 597, 560
Kentucky.......	78, 201, 800	3, 258, 410	32, 844, 756	9, 612, 600	1, 248, 390	9, 131, 970
Ohio.......	73, 560, 000	2, 818, 480	34, 573, 200	25, 884, 000	2, 588, 400	25, 625, 160
Michigan.......	21, 412, 300	911, 165	11, 134, 396	25, 011, 000	1, 786, 500	24, 010, 560
Indiana.......	95, 620, 000	3, 541, 482	39, 204, 200	28, 447, 800	2, 735, 370	27, 025, 410
Illinois.......	203, 786, 500	8, 151, 463	81, 514, 600	22, 150, 000	2, 215, 000	20, 378, 000
Wisconsin.......	23, 579, 300	1, 122, 826	11, 318, 064	19, 604, 900	1, 593, 900	17, 252, 312
Minnesota.......	15, 124, 800	727, 155	6, 503, 664	33, 773, 200	2, 597, 940	27, 018, 560

Summary for each State, showing the product, the area, and the value, &c.—Continued.

States and Territories.	Corn.			Wheat.		
	Bushels.	Acres.	Value.	Bushels.	Acres.	Value.
Iowa	169, 629, 000	6, 980, 621	$54, 281, 280	27, 518, 800	2, 435, 300	$22, 015, 040
Missouri	161, 655, 000	5, 878, 364	56, 579, 250	23, 819, 300	2, 358, 350	20, 960, 984
Kansas	172, 800, 900	4, 708, 473	44, 928, 234	26, 851, 100	1, 534, 350	20, 943, 858
Nebraska	101, 278, 900	2, 813, 303	24, 306, 936	27, 481, 300	1, 772, 990	19, 236, 910
California	2, 464, 800	100, 607	2, 095, 080	36, 322, 000	2, 794, 000	36, 322, 000
Oregon	129, 300	5, 504	96, 975	13, 122, 400	795, 300	11, 810, 160
Nevada	21, 100	847	8, 440	99, 200	5, 424	109, 120
Colorado	533, 100	21, 287	452, 285	2, 394, 000	114, 000	2, 298, 240
Arizona	54, 700	2, 736	47, 042	222, 200	15, 810	233, 310
Dakota	4, 915, 055	270, 058	2, 211, 775	16, 128, 000	1, 008, 000	11, 612, 160
Idaho	32, 500	1, 627	29, 250	682, 500	44, 687	614, 250
Montana	10, 040	502	9, 036	942, 000	57, 796	866, 640
New Mexico	930, 100	46, 506	771, 983	977, 900	65, 195	1, 026, 795
Utah	280, 100	13, 340	246, 488	1, 579, 400	83, 130	1, 453, 048
Washington	61, 400	2, 672	55, 260	3, 182, 700	170, 200	2, 705, 295
Wyoming				26, 500	1, 747	25, 970
Indian Territory						
Total	1, 551, 066, 895	68, 301, 889	658, 051, 485	421, 086, 160	36, 455, 593	383, 649, 272

Summary for each State, showing the product, the area, and the value, &c.—Continued.

States and Territories.	Oats.			Rye.		
	Bushels.	Acres.	Value.	Bushels.	Acres.	Value.
Maine	2, 665, 000	84, 579	$1, 199, 250	80, 712	2, 458	$29, 176
New Hampshire	1, 033, 000	29, 697	485, 510	29, 767	3, 280	27, 683
Vermont	3, 548, 600	102, 505	1, 561, 384	87, 516	6, 322	78, 764
Massachusetts	724, 000	23, 098	344, 760	422, 419	26, 638	346, 384
Rhode Island	179, 100	5, 882	85, 968	15, 837	1, 372	13, 145
Connecticut	1, 100, 700	37, 141	528, 336	441, 303	30, 302	361, 868
New York	42, 071, 400	1, 344. 637	16, 828, 560	2, 703, 816	241, 685	1, 946, 748
New Jersey	4, 265, 800	130, 873	1, 706, 320	1, 028, 976	101, 488	771, 732
Pennsylvania	38, 193, 200	1, 247, 868	15, 277, 280	4, 049, 595	402, 219	2, 834, 716
Delaware	517, 600	21, 664	207, 040	6, 669	840	4, 001
Maryland	2, 023, 800	100, 323	789, 282	314, 640	27, 899	195, 077
Virginia	6, 275, 600	628, 434	2, 949, 532	324, 368	50, 335	243, 276
North Carolina	5, 142, 000	593, 890	2, 622, 420	394, 274	64, 266	323, 305
South Carolina	3, 544, 000	362, 805	2, 232, 720	32, 832	8, 044	41, 040
Georgia	7, 018, 700	780, 682	3, 930 472	142, 560	26, 554	165, 370
Florida	504, 500	51, 528	398, 555	3, 595	737	4, 673
Alabama	4, 517, 300	427, 199	2, 574, 861	32, 203	5, 999	38, 644
Mississippi	3, 142, 400	274, 236	1, 885, 440	5, 347	884	6, 951
Louisiana	475, 000	34, 096	308, 750	7, 680	1, 224	10, 368
Texas	9, 489, 300	416, 096	4, 839, 543	57, 855	5, 040	60, 748
Arkansas	3, 225, 400	223, 961	1, 612, 700	27, 027	4, 419	25, 676
Tennessee	6, 997, 700	586, 490	2, 659, 126	190, 190	35, 779	138, 839
West Virginia	2, 020, 300	120, 829	808, 120	149, 985	17, 410	112, 489
Kentucky	6, 899, 900	422, 628	2, 552, 963	705, 104	90, 787	479, 471
Ohio	29, 560, 000	871, 250	10, 346, 000	282, 240	31, 245	169, 344
Michigan	20, 061, 300	580, 451	7, 021, 455	221, 705	22, 355	137, 457
Indiana	21, 304, 100	717, 560	6, 817, 312	250, 743	25, 258	162, 983
Illinois	102, 780, 000	2, 848, 555	27, 750, 600	5, 099, 640	324, 870	2, 753, 806
Wisconsin	40, 502, 700	1, 331, 392	12, 555, 837	2, 396, 530	170, 998	1, 198, 265
Minnesota	31, 447, 500	949, 200	8, 805, 300	466, 867	31, 440	233, 434
Iowa	68, 403, 600	2, 005, 569	17, 784, 936	1, 463, 076	122, 522	629, 123
Missouri	30, 374, 200	1, 057, 422	7, 593, 550	570, 851	51, 076	313, 968
Kansas	27, 560, 000	699, 476	5, 787, 600	4, 583, 500	269, 280	1, 695, 895
Nebraska	21, 630, 000	540, 161	4, 326, 000	1, 026, 080	64, 176	359, 128
California	1, 826, 600	70, 858	1, 059, 428	209, 587	29, 813	199, 108
Oregon	4, 211, 800	170, 903	2, 232, 254	19, 026	1, 312	16, 172
Nevada	212, 100	7, 344	127, 260			
Colorado	1, 209, 000	41, 250	725, 400	31, 046	1, 783	24, 837
Arizona	6, 000	240	3, 720			
Dakota	9, 000, 000	210, 000	2, 520, 000	174, 167	8, 014	95, 792
Idaho	1, 140, 000	30, 450	649, 800	13, 294	1, 013	11, 965
Montana	1, 210, 000	32, 200	701, 800			
New Mexico	199, 800	11, 760	119, 880			
Utah	546, 000	24, 050	311, 220	22, 821	2, 220	18, 257
Washington	2, 480, 400	62, 540	1, 364, 220	23, 139	1, 398	20, 825
Wyoming	63, 000	2, 100	37, 800			
Indian Territory						
Total	571, 302, 400	20, 324, 962	187, 040, 264	28, 058, 583	2, 314, 754	16, 300, 503

Summary for each State, showing the product, the area, and the value, &c.—Continued.

States and Territories.	Barley.			Buckwheat.		
	Bushels.	Acres.	Value.	Bushels.	Acres.	Value.
Maine	249, 856	10, 875	$199, 885	346, 080	20, 770	$190, 314
New Hampshire	74, 800	3, 672	60, 588	74, 290	4, 553	46, 069
Vermont	279, 214	11, 256	214, 995	310, 583	17, 685	192, 361
Massachusetts	77, 572	3, 248	63, 609	62, 415	5, 555	49, 932
Rhode Island	21, 266	808	17, 651	1, 204	126	1, 023
Connecticut	14, 344	626	10, 758	89, 206	10, 977	78, 149
New York	8, 649, 218	357, 662	6, 486, 913	2, 360, 634	290, 896	2, 030, 145
New Jersey	4, 198	249	3, 190	244, 608	35, 026	220, 147
Pennsylvania	578, 496	27, 556	422, 302	2, 467, 233	251, 369	2, 097, 148
Delaware				6, 515	428	4, 886
Maryland	6, 514	247	4, 885	117, 800	10, 573	94, 240
Virginia	18, 600	1, 211	14, 880	169, 065	16, 925	131, 871
North Carolina	2, 677	265	2, 142	49, 036	5, 953	36, 777
South Carolina	18, 223	1, 224	16, 401			
Georgia	23, 023	1, 666	23, 023			
Florida						
Alabama	6, 739	636	6, 739			
Mississippi						
Louisiana						
Texas	127, 030	7, 463	95, 272			
Arkansas						
Tennessee	45, 490	3, 112	32, 298	29, 674	5, 357	21, 365
West Virginia	11, 731	561	9, 385	226, 200	32, 451	180, 960
Kentucky	450, 468	20, 390	310, 823	11, 353	1, 213	10, 218
Ohio	938, 441	58, 562	703, 831	180, 804	21, 891	162, 724
Michigan	1, 079, 136	51, 371	701, 438	244, 858	32, 834	210, 578
Indiana	340, 956	15, 792	187, 526	70, 784	8, 158	63, 706
Illinois	876, 525	43, 520	482, 089	114, 019	16, 672	101, 477
Wisconsin	6, 061, 272	251, 688	3, 333, 700	177, 792	32, 171	133, 344
Minnesota	7, 276, 040	318, 270	3, 419, 739	30, 360	5, 772	22, 163
Iowa	4, 638, 348	211, 428	2, 087, 257	135, 270	17, 014	108, 216
Missouri	179, 982	8, 080	89, 991	63, 756	5, 728	47, 817
Kansas	347, 490	18, 794	138, 996	27, 720	2, 999	23, 285
Nebraska	3, 623, 880	163, 800	1, 340, 836	20, 808	2, 029	16, 646
California	10, 135, 854	625, 498	6, 385, 588	25, 806	1, 161	23, 225
Oregon	885, 060	32, 857	575, 289	8, 150	510	7, 335
Nevada	458, 640	22, 270	366, 912			
Colorado	157, 080	6, 064	117, 810			
Arizona	330, 775	17, 713	241, 466			
Dakota	731, 013	31, 100	292, 405	2, 931	553	2, 638
Idaho	339, 501	11, 977	254, 693			
Montana	50, 182	1, 945	36, 633			
New Mexico	58, 913	2, 887	47, 130			
Utah	296, 396	12, 114	198, 585			
Washington	671, 064	20, 552	422, 770			
Wyoming						
Indian Territory						
Total	50, 136, 097	2, 379, 009	29, 420, 423	7, 668, 954	857, 349	6, 303, 980

States and Territories.	Potatoes.			Hay.		
	Bushels.	Acres.	Value.	Tons.	Acres.	Value.
Maine	8, 219, 296	70, 856	$3, 945, 262	1, 214, 033	1, 083, 958	$12, 747, 347
New Hampshire	3, 489, 285	31, 435	1, 500, 393	597, 490	603, 534	6, 423, 114
Vermont	4, 708, 550	42, 805	1, 977, 591	1, 148, 100	964, 790	11, 021, 760
Massachusetts	4, 522, 080	37, 684	2, 532, 365	766, 885	623, 484	12, 576, 914
Rhode Island	845, 185	6, 985	507, 111	81, 708	71, 050	1, 348, 182
Connecticut	3, 625, 700	36, 257	1, 921, 621	625, 856	568, 960	9, 575, 597
New York	38, 472, 768	400, 758	15, 004, 380	6, 053, 833	4, 962, 158	63, 565, 247
New Jersey	4, 275, 857	44, 081	2, 351, 721	610, 751	508, 959	8, 397, 826
Pennsylvania	16, 185, 440	202, 318	7, 283, 448	3, 286, 286	2, 738, 572	34, 341, 689
Delaware	292, 810	4, 183	137, 621	56, 513	49, 142	734, 669
Maryland	1, 656, 564	21, 238	745, 454	343, 626	286, 355	4, 535, 863
Virginia	2, 443, 428	35, 412	1, 466, 057	335, 894	284, 656	3, 929, 960
North Carolina	1, 312, 935	20, 199	892, 796	96, 434	83, 856	1, 038, 594
South Carolina	179, 100	3, 582	152, 235	3, 050	3, 050	39, 650
Georgia	565, 348	9, 268	486, 199	18, 700	15, 583	252, 450
Florida	159, 808	1, 816	143, 827	283	230	3, 679
Alabama	587, 598	8, 903	528, 838	14, 712	11, 317	209, 646
Mississippi	518, 049	8, 223	440, 342	13, 643	10, 106	191, 002
Louisiana	440, 625	5, 995	359, 700	41, 209	30, 525	546, 019

Summary for each State, showing the product, the area, and the value, &c.—Continued.

States and Territories.	Potatoes.			Hay.		
	Bushels.	Acres.	Value.	Tons.	Acres.	Value.
Texas	492, 900	8, 215	$443, 610	107, 249	77, 717	$1, 136, 839
Arkansas	717, 278	11, 569	516, 440	36, 385	25, 989	391, 139
Tennessee	2, 404, 647	38, 169	1, 033, 998	244, 843	188, 341	2, 448, 430
West Virginia	2, 264, 958	26, 034	1, 064, 530	279, 124	232, 603	3, 344, 642
Kentucky	4, 255, 600	53, 195	1, 829, 908	270, 738	208, 260	2, 639, 696
Ohio	16, 452, 315	166, 185	6, 580, 926	3, 220, 342	2, 300, 244	30, 593, 249
Michigan	11, 811, 979	142, 313	4, 842, 911	1, 767, 641	1, 280, 899	16, 439, 061
Indiana	8, 477, 010	94, 189	2, 797, 413	1, 876, 595	1, 285, 339	15, 951, 058
Illinois	12, 978, 440	141, 070	4, 672, 238	4, 270, 062	2, 944, 870	30, 957, 950
Wisconsin	10, 127, 912	110, 086	3, 342, 211	2, 354, 835	1, 682, 025	16, 483, 845
Minnesota	5, 839, 000	58, 390	1, 576, 530	2, 054, 888	1, 522, 139	9, 246, 996
Iowa	13, 216, 868	134, 866	3, 700, 723	4, 372, 849	3, 363, 730	19, 677, 821
Missouri	6, 535, 570	75, 995	2, 614, 228	1, 400, 021	1, 120, 017	9, 100, 137
Kansas	6, 361, 520	79, 519	3, 307, 990	5, 075, 000	3, 500, 000	19, 031, 250
Nebraska	3, 467, 124	42, 282	1, 040, 137	1, 123, 601	749, 067	3, 932, 604
California	4, 440, 906	54, 826	2, 664, 544	1, 307, 045	871, 363	16, 338, 063
Oregon	941, 120	11, 764	658, 784	315, 210	203, 361	4, 018, 928
Nevada	415, 815	4, 377	311, 861	129, 487	83, 540	1, 715, 703
Colorado	506, 515	5, 959	329, 235	114, 505	81, 789	1, 545, 818
Arizona	52, 936	1, 018	42, 349	10, 710	12, 600	139, 230
Dakota	1, 265, 355	12, 285	379, 607	585, 200	418, 000	2, 194, 500
Idaho	269, 280	2, 640	193, 882	65, 520	50, 400	524, 160
Montana	270, 375	2, 575	189, 263	110, 664	92, 220	1, 161, 972
New Mexico	32, 130	459	32, 130	13, 860	11, 550	152, 460
Utah	949, 416	9, 129	683, 580	174, 720	124, 800	628, 992
Washington	1, 003, 530	9, 123	551, 942	252, 450	168, 300	3, 281, 850
Wyoming	104, 500	1, 045	71, 060	21, 450	16, 500	278, 850
Indian Territory	...	...	...	...	...	...
Total	208, 164, 425	2, 289, 275	87, 849, 991	46, 864, 009	35, 515, 948	383, 834, 451

States and Territories.	Tobacco.			Cotton.		
	Pounds.	Acres.	Value.	Bales.	Acres.	Value.
Maine	...	...	...	...	...	...
New Hampshire	145, 978	107	$18, 977	...	...	...
Vermont	...	...	...	...	...	...
Massachusetts	4, 038, 278	2, 814	533, 053	...	...	...
Rhode Island	...	...	...	...	...	...
Connecticut	9, 576, 824	8, 145	1, 292, 871	...	...	...
New York	9, 068, 789	5, 440	1, 178, 943	...	...	...
New Jersey	...	...	...	...	...	...
Pennsylvania	36, 322, 099	28, 879	4, 358, 652	...	...	...
Delaware	...	...	...	...	...	...
Maryland	31, 570, 793	40, 593	2, 052, 102	...	...	...
Virginia	67, 865, 972	129, 996	5, 429, 278	17, 300	55, 786	$735, 250
North Carolina	29, 048, 213	60, 000	3, 631, 027	398, 200	1, 050, 543	17, 321, 700
South Carolina	...	...	...	409, 600	1, 618, 989	20, 662, 400
Georgia	...	...	...	752, 500	2, 872, 748	33, 110, 000
Florida	...	...	...	58, 900	257, 799	2, 650, 500
Alabama	...	...	...	630, 400	2, 610, 420	8, 052, 800
Mississippi	...	...	...	901, 300	2, 278, 521	39, 657, 200
Louisiana	...	...	...	490, 200	931, 900	21, 568, 800
Texas	...	...	...	1, 118, 000	3, 034, 922	49, 192, 000
Arkansas	1, 100, 000	2, 300	95, 700	518, 500	1, 188, 545	22, 814, 000
Tennessee	28, 538, 602	40, 221	1, 712, 316	310, 700	807, 602	13, 360, 100
West Virginia	1, 952, 872	4, 108	205, 052	...	...	...
Kentucky	171, 059, 155	230, 116	14, 711, 087	...	...	...
Ohio	29, 947, 536	32, 128	2, 395, 803	...	...	...
Michigan	...	...	...	...	...	...
Indiana	8, 471, 240	11, 863	635, 343	...	...	...
Illinois	3, 155, 462	5, 679	252, 437	...	...	...
Wisconsin	5, 743, 828	12, 750	631, 821	...	...	...
Minnesota	...	...	...	...	...	...
Iowa	...	...	...	...	...	...
Missouri	10, 540, 000	15, 400	895, 900	35, 000	70, 218	1, 470, 000
Kansas	...	...	...	...	...	...
Nebraska, California, and other States	3, 400, 000	8, 200	425, 000	...	...	...
Total	451, 545, 641	638, 739	40, 455, 362	5, 700, 600	16, 777, 993	250, 594, 750

Table showing the average yield per acre and the price per bushel, pound, or ton, of fa[rm] products for the year 1883.

States and Territories.	Corn.		Wheat.		Oats.		Rye.		Barley.	
	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Bushels.	Price per bushel.
Maine	35.0	$0 82	14.2	$1 40	31.5	$0 45	12.5	$0 95	23.0	$0 80
New Hampshire	36.0	82	15.8	1 38	34.8	47	9.1	93	20.4	81
Vermont	31.0	79	16.4	1 24	34.6	44	13.8	90	24.8	77
Massachusetts	35.0	80	16.7	1 45	31.3	49	15.9	82	23.9	85
Rhode Island	32.0	85	15.3	1 40	30.4	48	11.5	83	26.3	80
Connecticut	30.0	81	15.8	1 25	29.6	48	14.6	83	22.9	75
New York	23.0	73	10.3	1 11	31.3	40	11.2	72	24.2	75
New Jersey	28.0	65	13.4	1 10	32.6	40	10.1	75	16.9	76
Pennsylvania	27.0	67	13.2	1 08	30.6	40	10.1	70	21.6	78
Delaware	18.0	50	10.3	1 11	23.9	40	7.9	60	......	......
Maryland	23.5	51	12.1	1 06	20.2	39	11.3	62	26.4	75
Virginia	14.0	60	9.0	1 05	10.0	47	6.4	75	15.4	80
North Carolina	11.5	65	5.9	1 17	8.7	51	6.1	82	10.1	80
South Carolina	8.0	73	5.2	1 30	9.8	63	4.1	1 25	14.9	90
Georgia	8.7	67	5.1	1 20	9.0	56	5.4	1 16	13.8	1 00
Florida	8.5	82	......	......	9.8	79	4.9	1 30	......	......
Alabama	11.5	64	5.2	1 15	10.6	57	5.4	1 20	10.6	1 00
Mississippi	13.5	63	5.0	1 20	11.5	60	6.0	1 30	......	......
Louisiana	14.2	66	......	......	13.9	65	6.8	1 35	......	......
Texas	17.5	60	8.5	1 00	22.8	51	11.5	1 05	17.0	75
Arkansas	17.5	53	6.1	1 03	14.4	50	6.1	95	......	......
Tennessee	20.0	44	5.6	92	11.9	38	5.3	73	14.6	71
West Virginia	24.3	58	10.0	1 08	15.6	40	8.6	75	20.9	80
Kentucky	24.0	42	7.7	95	16.3	37	7.8	68	22.1	60
Ohio	26.1	47	10.0	99	33.9	35	9.0	60	16.0	75
Michigan	23.5	52	14.0	96	34.6	35	9.9	62	21.0	65
Indiana	27.0	41	10.4	95	29.7	32	9.9	65	21.6	55
Illinois	25.0	40	10.0	92	36.1	27	15.7	54	20.1	55
Wisconsin	21.0	48	12.3	88	30.4	31	14.0	50	24.1	55
Minnesota	20.8	43	13.0	80	33.1	28	14.8	50	22.9	47
Iowa	24.3	32	11.3	80	34.1	26	11.9	43	21.9	45
Missouri	27.5	35	10.1	88	28.7	25	11.2	55	22.3	50
Kansas	36.7	26	17.5	78	39.4	21	17.0	37	18.5	40
Nebraska	36.0	24	15.5	70	40.0	20	16.0	35	22.1	37
California	24.5	85	13.0	1 00	25.8	58	7.0	95	16.2	63
Oregon	23.5	75	16.5	90	24.6	53	14.5	85	26.9	65
Nevada	24.9	40	18.3	1 10	28.9	60	......	......	20.6	80
Colorado	25.0	85	21.0	96	29.8	60	17.4	80	25.9	75
Arizona	20.0	86	14.0	1 05	25.0	62	......	......	18.7	73
Dakota	18.2	45	16.0	72	42.9	28	21.7	55	23.5	40
Idaho	20.0	90	15.3	90	37.4	57	18.1	90	28.4	75
Montana	20.0	90	16.3	92	37.6	58	......	......	25.8	73
New Mexico	20.0	83	15.0	1 05	17.0	60	......	......	20.4	80
Utah	21.0	88	19.0	92	22.7	57	10.8	80	24.5	67
Washington	23.0	90	18.7	85	39.7	55	16.6	90	32.7	63
Wyoming	......	......	15.2	98	30.0	60	......	......	......	......
	22.7	42	11.6	91	28.1	33	12.1	58	21.1	58.7

States and Territories.	Buckwheat.		Potatoes.		Hay.		Tobacco.		Cotton.	
	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Tons.	Price per ton.	Pounds.	Price per pound.	Gross pounds per acre.	Price per pound.
								Cents.		*Cents.*
Maine	16.7	$0 55	116	$0 48	1.12	$10 50	......	......	......	......
New Hampshire	16.3	62	111	43	.99	10 75	1,364	13.0	......	......
Vermont	17.6	62	110	42	1.19	9 60	......	......	......	......
Massachusetts	11.2	80	120	56	1.23	16 40	1,435	13.2	......	......
Rhode Island	9.6	85	121	60	1.15	16 50	......	......	......	......
Connecticut	8.1	82	100	53	1.10	15 30	1,176	13.5	......	......
New York	8.1	86	96	39	1.22	10 50	1,667	13.0	......	......
New Jersey	7.0	90	97	55	1.20	13 75	......	......	......	......
Pennsylvania	9.8	85	80	45	1.20	10 45	1,258	12.0	......	......
Delaware	15.2	75	70	47	1.15	13 00	......	......	......	......
Maryland	11.1	80	78	45	1.20	13 20	778	6.5	......	......
Virginia	10.0	78	69	60	1.18	11 70	522	8.0	147	9.0
North Carolina	8.2	75	65	68	1.15	10 77	484	12.5	177	9.3
South Carolina	......	......	50	85	1.00	13 00	......	......	136	9.4
Georgia	......	......	61	86	1.20	13 50	......	......	123	9.4
Florida	......	......	88	90	1.23	13 00	......	......	74	14.6

Table showing the average yield per acre and the price per bushel, pound, or ton, of farm products for the year 1883—Continued.

States and Territories.	Buckwheat.		Potatoes.		Hay.		Tobacco.		Cotton.	
	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Tons.	Price per ton.	Pounds.	Price per pound.	Gross pounds per acre.	Price per pound.
								Cents.		Cents.
Alabama	....	....	66	$0 90	1.30	$14 25	....	....	120	9.0
Mississippi	....	....	63	85	1.35	14 00	....	....	192	9.1
Louisiana	....	....	75	80	1.35	13 25	....	....	252	9 2
Texas	....	....	60	90	1.38	10 60	....	....	187	8.6
Arkansas	....	....	62	72	1.40	10 75	478	8.7	218	8.8
Tennessee	5.5	$0 72	63	43	1.30	10 00	710	6.0	191	8.7
West Virginia	7.0	80	87	47	1.20	8 40	475	10.5	....	....
Kentucky	9.4	90	80	43	1.30	9 75	748	8.6	....	....
Ohio	8.3	90	99	40	1.40	9 50	932	8.0	....	....
Michigan	7.5	86	83	41	1.38	9 30	....	....	....	....
Indiana	8.7	90	90	33	1.46	8 50	714	7.5	....	....
Illinois	6.8	89	92	36	1.45	7 25	556	8.0	....	....
Wisconsin	5.5	75	92	33	1.40	7 00	450	11.0	....	....
Minnesota	5.3	73	100	27	1.35	4 50	....	....	....	....
Iowa	8.0	80	98	28	1.30	4 50	....	....	....	....
Missouri	11.1	75	86	40	1.25	6 50	684	8.5	....	....
Kansas	9.2	84	80	52	1.40	3 75			....	....
Nebraska	10.3	80	82	30	1.50	3 50			....	....
California	22.2	90	81	60	1.50	12 50			....	....
Oregon	16.0	90	80	70	1.55	12 75			....	....
Nevada	....	....	95	75	1.55	13 25			....	....
Colorado	....	....	85	65	1.40	13 50			....	....
Arizona	....	....	52	80	.85	13 00	415	12.5	....	....
Dakota	5.3	90	103	30	1.40	3 75			....	....
Idaho	....	....	102	72	1.30	8 00			....	....
Montana	....	....	105	70	1.20	10 50			....	....
New Mexico	....	....	70	1 00	1.20	11 00			....	....
Utah	....	....	104	72	1.40	3 60			....	....
Washington	....	....	110	55	1.50	13 00			....	....
Wyoming	....	....	100	68	1.30	13 00			....	....
	8.9	82	91	42	1.32	8 19	707	9.0	165	9.0

Table showing the average cash value per acre of farm products for the year 1883.

States and Territories.	Corn.	Wheat.	Rye.	Oats.	Barley.	Buckwheat.	Potatoes.	Tobacco.	Hay.
Maine	$28 70	$19 88	$11 87	$14 17	$18 40	$9 18	$65 68	....	$11 76
New Hampshire	29 52	21 80	8 46	16 36	16 52	10 11	47 73	$177 36	10 64
Vermont	24 49	20 34	12 42	15 22	19 10	10 91	46 20	....	11 42
Massachusetts	28 00	24 21	13 04	15 34	19 60	8 96	67 20	189 43	20 17
Rhode Island	27 20	21 42	9 54	14 59	21 83	8 16	72 60	....	18 98
Connecticut	24 80	19 75	11 97	14 21	17 17	6 64	53 00	158 73	16 83
New York	16 79	11 43	8 06	12 52	18 15	6 97	37 44	216 72	12 81
New Jersey	18 20	14 74	7 57	13 04	12 84	6 30	53 35	....	16 50
Pennsylvania	18 09	14 26	7 07	12 24	15 33	8 33	36 00	150 93	12 54
Delaware	9 00	11 43	4 74	9 56	....	11 40	32 90	....	14 95
Maryland	11 98	12 83	7 01	7 88	19 80	8 88	35 10	50 55	15 84
Virginia	8 40	9 46	4 80	4 70	12 92	7 80	41 40	41 76	13 81
North Carolina	7 47	6 90	5 00	4 44	8 08	6 15	44 20	60 52	12 39
South Carolina	5 84	6 76	5 12	6 17	13 41	....	42 50	....	18 00
Georgia	5 83	6 12	6 26	5 04	13 80	....	52 46	....	16 20
Florida	6 97	....	6 37	7 74		....	79 20	....	16 00
Alabama	7 36	5 98	6 48	6 04	10 60	....	59 40	....	18 52
Mississippi	8 50	6 00	7 80	6 90	....	....	53 55	....	18 90
Louisiana	9 37	....	8 50	9 03	....	....	60 00	....	17 89
Texas	10 50	8 50	12 07	11 63	12 75	....	54 00	....	14 63
Arkansas	9 27	6 28	5 79	7 20	....	....	44 64	41 61	15 05
Tennessee	8 80	5 15	3 87	4 52	10 37	3 96	27 09	42 57	13 00
West Virginia	12 88	10 80	6 45	6 24	16 72	5 60	40 89	49 92	10 08
Kentucky	10 08	7 31	5 30	6 03	15 25	8 46	34 40	63 93	12 68
Ohio	12 27	9 90	5 40	11 86	12 00	7 47	39 60	74 57	13 30
Michigan	12 22	13 44	6 14	12 11	13 65	6 45	34 03	....	12 83
Indiana	11 07	9 88	6 43	9 50	11 88	7 83	29 70	53 56	12 41
Illinois	10 00	9 20	8 48	9 75	11 05	6 05	33 12	44 45	10 51
Wisconsin	10 08	10 82	7 00	9 42	13 25	4 12	30 36	49 55	9 80
Minnesota	8 94	10 40	7 40	9 27	10 76	3 87	27 00	....	6 66
Iowa	7 78	9 04	5 12	8 87	9 85	6 40	27 44	....	5 85
Missouri	9 62	8 89	6 16	7 17	11 15	8 32	34 40	58 18	8 12

Table showing the average cash value per acre of farm products for the year 1883—Cont'd.

States and Territories.	Corn.	Wheat.	Rye.	Oats.	Barley.	Buck-wheat.	Potatoes.	Tobacco.	Hay.
Kansas	$9 54	$13 65	$6 29	$8 27	$7 40	$7 73	$41 60	*$51 83	$5 44
Nebraska	8 64	10 85	5 60	8 00	8 18	8 24	24 60		5 25
California	20 82	13 00	6 65	14 96	10 21	19 98	48 60		18 75
Oregon	17 62	14 55	12 32	13 04	17 48	14 40	56 00		19 76
Nevada	9 96	20 13	....	17 34	16 48	....	71 25		20 54
Colorado	21 25	20 16	13 92	17 58	19 42	....	55 25		18 90
Arizona	17 20	14 70	....	15 50	13 65	....	41 60		11 05
Dakota	8 19	11 52	11 93	12 01	9 40	4 77	30 90		5 25
Idaho	18 00	13 77	11 79	21 32	21 30	....	73 44		10 40
Montana	18 00	15 00	....	21 81	18 83	....	73 50		12 60
New Mexico	16 60	15 75	....	10 20	16 32	....	70 00		13 20
Utah	18 48	17 48	8 24	12 94	16 41	....	74 88		5 64
Washington	20 70	15 89	14 94	21 83	20 60	....	60 50		19 50
Wyoming	....	14 90	....	18 00	....	....	68 00		16 90
Indian Territory	....	....	....	....	....	....	....	....	....
United States	9 63	10 56	7 02	9 27	12 38	7 80	38 37	63 34	10 81

* All other States and Territories.

A general summary, showing the estimated quantities, number of acres, and aggregate value of principal crops of the farm in 1883.

Products.	Quantity produced.	Number of acres.	Value.
Corn .... bushels..	1,551,066,895	68,301,889	$658,051,485
Wheat .... do....	421,086,160	36,455,593	383,649,272
Rye .... do....	28,058,583	2,314,754	18,300,508
Oats .... do....	571,302,400	20,324,962	187,040,264
Barley .... do....	50,136,097	2,379,009	29,420,423
Buckwheat .... do....	7,668,954	857,349	6,303,980
Potatoes .... do....	208,164,425	2,289,275	87,849,991
Total	2,837,483,514	132,922,831	1,369,615,918
Tobacco .... pounds..	451,545,641	638,739	40,455,362
Hay .... tons..	46,864,009	35,515,948	383,834,451
Cotton .... bales..	5,700,600	16,777,993	250,594,750
Grand total	....	....	....

Table showing the estimated average yield and cash value per acre, and price per bushel, pound, or ton, of farm products for the year 1883.

Products.	Average yield per acre.	Average price per bushel.	Average value per acre.	Products.	Average yield per acre.	Average price per bushel.	Average value per acre.
Indian corn . bushels..	22.7	$0 42.0	$9 63	Buckwheat . bushels.	8.9	$0 82	$7 30
Wheat .... do....	11.6	91.0	10 56	Potatoes ...... do....	91.0	42	38 37
Rye .... do....	12.1	58.0	7 02	Tobacco ... pounds..	707.0	9	63 34
Oats .... do....	28.1	33.0	9 27	Hay .... tons..	1.32	8 19	10 81
Barley .... do....	21.1	58.7	12 38	Cotton .... bales..	.34	14 92	43 96

FARM ANIMALS.

NUMBERS.

The largest increase of numbers during the past year has been of stock cattle. In the South there has been a slight decrease, caused by the movement to Texas and the Indian Territory, to swell the numbers driven to the plains and mountains, which have become the great pasture lands of the United States.

The number of cows is steadily increasing with increase of population, and is largest in the more rapidly growing Western States.

The increase in horses has been large, and not confined to any section, though largest beyond the Mississippi, in the newer States and in the Territories beyond. A slight enlargement of the number of mules is indicated.

The numbers of sheep have slightly decreased in the older States, in sympathy with the tendency to decline in values of sheep and wool; but the deficiency has been made up by some enlargement of flocks in the Territories.

The aggregate numbers of each class of stock are thus compared with those of the previous return:

Stock.	1883.	1884.	Increase.
Horses	10, 838, 111	11, 169, 683	331, 572
Mules	1, 871, 079	1, 914, 126	43, 747
Milch cows	13, 125, 685	13, 501, 206	369, 521
Oxen and other cattle	28, 046, 077	29, 046, 101	1, 000, 024
Sheep	49, 237, 291	50, 626, 626	1, 389, 335
Swine	43, 270, 086	44, 200, 893	930, 807

The drain of cattle from Texas to supply the West Indies trade, the shipments to New Orleans and other points by rail and steamer, and the drives north through the Indian Territory, have taken all the annual increase, and caused a slight reduction in the number remaining in the State, if the returns accurately represent the numbers.

The movement westward from the other Gulf States may have been facilitated by the drought prevailing in that section. Many correspondents assign this as a cause of reduction of numbers by sales and drives towards Texas.

While the movement of cattle from Georgia, Alabama, and Mississippi is mainly to Texas, there is also a similar movement within that State towards the cheaper land along its western borders, as well as the usual movement across its northern boundary to the pasture lands of New Mexico, Colorado, Kansas, and other grazing States and Territories. In Austin County, Texas, a decrease in the number of cattle is reported as the result of heavy losses last winter; while a report from Bexar County, in the same State, mentions the severity of the present winter as a cause of suffering, the stock being already considerably reduced in condition. In Williamson County: "Decrease is due to large numbers being driven further west, to better range." In Callahan County: "Decrease is caused by removal of many to range further west, the moving made necessary by the largely increased settlement." Matagorda: "Decrease is due to large sales for Kansas drives."

Another movement of neat stock westward is that of calves from the Ohio Valley, and from more eastern States. From Shelby County, Kentucky, come reports of "large numbers of young cattle shipped to the West." Michigan reports indicate a decrease from sale of fat cattle and movement of younger stock, on account of the failure of the corn crop. Portions of Minnesota report the same cause of decrease.

So sharp has been the competition for stock by the great cattle syndicates of the mountains, formed by a combination of Eastern and European capital, that the movement towards the great district covered by New Mexico, Colorado, Wyoming, Montana, and other Territories has been general, drawing stock, young or old, or all ages indiscriminately, from all sections of the East and from the Pacific coast.

Iowa and Missouri, States not yet fully occupied, have furnished recruits for this mountain army of occupation. The correspondent for Holt County, Missouri, reports that "large numbers are sent to Nebraska for ranch stock." The report from Iowa County, Iowa, says that "a great many young cattle have been sent to Nebraska, and fewer are fed than usual."

It is gratifying to observe that in the Southern States there is unusual interest in stock improvement, and many reports are made of the introduction of Short-horns and Herefords for beef, and Holsteins and Jerseys for milk.

There is evidently abroad in the land a desire for better breeds and better methods of feeding and treatment, more general, probably, than at any previous period. As prices advance, and the difference in stock value between scrubs and animals that honor their pedigrees becomes more generally apparent, better blood and feed will be more appreciated, and greater care given to cattle. And as prices advance, and margins for profit are closer, the economies of feeding will be more inquired into, scientific aids invoked, and some effort made towards saving the one hundred million dollars, more or less, unnecessarily lost in feed consumed "for fuel," on account of exposure to wet and cold, avoidable by provision of shelter and suitable warmth for fattening animals. Corn and hay are the most expensive materials for shelter that can be used in the protection of fattening cattle.

VALUES.

There has been an increase in the values of horses, mules, and all kinds of cattle, with a considerable decline in the prices of swine, and a small falling off in the values of sheep. The comparison of average values with those of last year is as follows:

Stock.	1883.	1884.
Horses	$70 59	$74 64
Mules	79 49	84 22
Milch cows	30 21	31 37
Oxen and other cattle	21 80	23 52
Sheep	2 53	2 37
Swine	6 75	5 57

In the case of swine prices are always fluctuating from various causes, the principal being the ups and downs in corn values. The home consumption rules the price of corn, which, therefore, varies with the product made; and stock hogs and pork products sympathize with these fluctuations. It sometimes happens, as in some places this season, that the abundance of corn which must be consumed at once has increased prices of stock hogs above the probable relative value of the hogs when ready for market, because of their comparative scarcity.

The corn failure of 1881 made pork very high in 1882, while the larger harvest of that year has had some effect in reducing the value of swine. Very low rates for swine or hog products cannot be expected while the corn supply is below an average, as it has been since 1881. The reduction in exportation of corn, by reason of the high price, cannot add much to the home supply; and the loss in exportation of pork products, both from high prices and hostile foreign legislation, is not a sufficient factor to make pork as cheap as in the era of surplus corn production.

The effect of the reduction of the tariff on wool is referred to very

ally throughout the farming portions of the country, and it is a of discouragement also in Texas and in the other pastoral districts. ost places the feeling of discouragement has not been permitted ıme the phase of a panic, causing slaughter for pelts and tallow. ng has prevailed that from favorable legislation, or other causes, may rally, which has exercised a conservative influence towards ing flocks a little longer. A small further decline might precipi- disastrous panic among wool-growers. In some places there has dispersion of flocks. In Walworth County, Wisconsin, sheep been sold by thousands. Statements of decrease from this cause from the extreme West, from Iowa and Missouri, as well as from n States.

me parts of Texas, the low price of wool, as a cause of discour- ent, is supplemented by the rising value of land.

losses by dogs are an ever present and almost universal cause of laint.

showing the estimated numbers of animals on farms, total value of each kind, and average price, January, 1884.

and Territories.	Horses.			Mules.		
	Number.	Average price.	Value.	Number.	Average price.	Value.
	88,509	$82 31	$7,285,176	304	$81 44	$24,758
mpshire	49,385	79 76	3,938,948	89	80 00	7,120
t.	76,880	78 36	6,024,317	300	90 00	27,000
usetts	61,429	104 72	6,432,845	249	115 00	28,635
sland	9,758	102 58	1,000,976	46	112 00	5,152
icut	47,223	98 70	4,660,910	555	110 00	61,050
rk	628,853	95 48	60,042,884	5,082	111 19	565,068
rsey	89,574	103 00	9,226,122	9,286	121 14	1,124,906
vania	557,920	96 31	53,733,275	23,909	110 74	2,647,683
re	21,999	93 57	2,058,446	4,001	113 30	453,313
d	122,788	83 85	10,295,774	12,839	112 12	1,439,509
	225,897	73 32	16,562,768	34,002	88 41	3,006,117
arolina	137,055	77 21	10,582,017	84,749	84 32	7,146,036
arolina	60,948	96 68	5,892,453	69,718	102 80	7,167,010
	102,695	84 37	8,664,377	139,653	96 60	13,490,480
	27,202	85 30	2,320,331	11,221	97 56	1,194,721
a.	119,727	73 67	8,820,288	127,221	92 22	11,732,321
ppi	120,294	75 29	9,056,935	139,058	91 20	12,682,090
na.	110,749	59 74	6,616,145	75,830	89 19	6,763,278
	889,063	38 87	34,557,879	149,121	59 30	8,842,875
as	161,455	58 95	9,517,772	102,729	69 14	7,102,683
ee	274,704	71 24	19,569,913	178,191	77 59	13,825,840
irginia	126,510	70 25	8,887,327	6,349	79 94	507,539
ky	370,028	74 08	27,411,674	113,785	79 35	9,028,840
	724,414	83 05	60,162,583	21,601	90 46	1,954,026
n	408,005	85 33	34,815,067	5,606	103 90	582,463
	593,131	77 13	45,748,194	52,815	85 81	4,532,055
	1,028,094	77 33	79,502,509	123,265	86 26	10,632,839
sin	381,296	81 93	31,239,581	7,423	96 23	714,315
ta	306,399	82 00	25,124,718	9,853	99 83	983,625
	891,173	76 98	68,602,498	48,066	91 89	4,416,785
i.	701,702	60 59	42,516,124	194,917	74 88	14,595,385
	522,945	72 57	37,950,119	75,073	91 55	6,872,933
ta	284,753	77 59	22,093,985	24,958	94 13	2,349,297
ia.	252,595	61 33	15,491,651	29,765	80 18	2,386,558
	142,222	63 10	8,974,208	2,917	73 81	215,304
	39,326	55 47	2,181,413	1,406	87 01	122,336
o	94,000	65 89	6,193,660	7,200	93 70	674,640
	8,628	57 00	491,796	1,075	70 00	75,250
	84,240	79 52	6,698,765	3,872	98 33	380,734
	29,252	56 00	1,638,112	796	72 00	57,312
a	45,885	55 07	2,526,887	1,022	73 17	74,780
xico	17,139	43 50	745,546	10,183	53 77	547,540
	48,510	47 87	2,322,174	3,152	62 73	197,725
gton	68,994	68 68	4,738,508	874	85 87	75,050
g	16,335	50 00	816,750			
Territory						
tal	11,169,683	74 64	833,734,400	1,914,126	84 22	161,214,976

Table showing the estimated numbers of animals on farms, total value of each kind, and average price, January, 1884—**Continued.**

States and Territories.	Milch cows.			Oxen and other cattle.		
	Number.	Average price.	Value.	Number.	Average price.	Value.
Maine	162, 095	$34 50	$5, 592, 277	188, 919	$32 03	$6, 051, 076
New Hampshire	95, 157	32 62	3, 104, 021	141, 784	33 44	4, 741, 257
Vermont	230, 317	31 00	7, 139, 827	187, 933	32 91	6, 184, 875
Massachusetts	160, 226	38 50	6, 168, 701	108, 393	34 71	3, 762, 321
Rhode Island	21, 882	35 50	776, 811	13, 427	38 51	517, 074
Connecticut	121, 006	33 42	4, 044, 021	113, 440	34 97	3, 966, 997
New York	1, 510, 904	36 33	54, 891, 142	886, 041	37 34	33, 084, 771
New Jersey	164, 566	39 33	6, 472, 381	69, 947	37 57	2, 627, 909
Pennsylvania	884, 351	36 66	32, 420, 308	875, 994	31 75	27, 812, 809
Delaware	27, 842	35 60	991, 175	26, 525	32 54	863, 123
Maryland	124, 750	36 25	4, 522, 187	139, 592	26 41	3, 686, 625
Virginia	245, 353	22 85	5, 606, 316	436, 820	20 55	8, 976, 651
North Carolina	234, 339	17 00	3, 983, 763	419, 508	10 84	4, 547, 467
South Carolina	137, 763	22 33	3, 076, 248	216, 880	11 75	2, 548, 340
Georgia	341, 048	19 04	6, 493, 554	610, 811	11 75	7, 177, 029
Florida	46, 054	14 30	658, 572	560, 000	9 18	5, 140, 800
Alabama	279, 668	16 51	4, 617, 319	480, 100	11 33	5, 439, 533
Mississippi	274, 829	16 75	4, 603, 386	420, 499	10 81	4, 545, 594
Louisiana	153, 452	20 43	3, 135, 024	271, 603	12 22	3, 318, 989
Texas	667, 501	24 50	16, 353, 774	4, 277, 700	17 51	74, 902, 527
Arkansas	257, 752	21 67	5, 585, 486	420, 876	13 66	5, 749, 166
Tennessee	313, 742	23 52	7, 379, 212	466, 084	16 74	7, 802, 246
West Virginia	161, 378	31 06	5, 012, 401	289, 519	25 56	7, 400, 106
Kentucky	304, 720	32 28	9, 836, 362	498, 888	27 65	13, 794, 253
Ohio	781, 996	36 50	28, 542, 854	1, 017, 820	29 42	29, 944, 264
Michigan	404, 078	36 44	14, 724, 602	491, 792	27 99	13, 765, 258
Indiana	504, 793	35 00	17, 667, 755	851, 355	26 85	22, 858, 882
Illinois	900, 984	35 00	31, 534, 440	1, 442, 344	28 04	40, 443, 326
Wisconsin	532, 734	32 50	17, 313, 855	682, 743	26 67	18, 208, 756
Minnesota	343, 864	31 50	10, 831, 716	427, 084	25 56	10, 916, 267
Iowa	1, 085, 077	31 75	34, 451, 195	1, 955, 810	26 00	50, 851, 060
Missouri	674, 565	28 00	18, 887, 820	1, 335, 082	22 62	30, 199, 555
Kansas	526, 933	33 60	17, 704, 949	1, 395, 200	27 12	37, 837, 824
Nebraska	255, 544	33 00	8, 432, 952	1, 368, 500	26 44	36, 183, 140
California	220, 708	38 00	8, 386, 904	609, 500	29 15	17, 766, 925
Oregon	65, 616	36 00	2, 362, 176	535, 600	26 21	14, 038, 076
Nevada	16, 029	37 33	598, 363	218, 360	27 15	5, 928, 474
Colorado	43, 114	40 60	1, 750, 428	772, 560	26 47	20, 449, 663
Arizona	13, 057	32 50	424, 352	203, 000	20 00	4, 060, 000
Dakota	75, 937	33 37	2, 534, 018	270, 600	26 69	7, 222, 314
Idaho	15, 862	37 50	594, 825	204, 750	26 00	5, 323, 500
Montana	14, 239	37 00	526, 843	672, 600	26 16	17, 595, 216
New Mexico	16, 743	35 00	586, 005	690, 562	20 01	13, 818, 146
Utah	38, 473	35 12	1, 351, 172	132, 180	23 89	3, 157, 780
Washington	45, 632	36 50	1, 665, 568	230, 376	24 84	5, 722, 540
Wyoming	4, 533	33 00	149, 589	897, 900	26 15	23, 456, 550
Indian Territory	....	....	....	520, 000	17 00	8, 840, 000
Total	13, 501, 206	31 37	423, 486, 649	29, 046, 101	23 52	683, 229, 054

States and Territories.	Sheep.			Hogs.		
	Number.	Average price.	Value.	Number.	Average price.	Value.
Maine	577, 236	$2 82	$1, 627, 806	71, 416	$9 64	$688, 450
New Hampshire	209, 686	3 00	629, 058	55, 056	10 94	602, 313
Vermont	448, 712	4 53	2, 032, 665	74, 864	8 64	646, 825
Massachusetts	69, 346	4 00	277, 384	80, 099	13 70	1, 097, 356
Rhode Island	21, 077	4 04	85, 151	14, 549	11 90	173, 133
Connecticut	58, 831	3 85	226, 499	62, 406	9 84	614, 075
New York	1, 732, 332	3 65	6, 323, 012	736, 796	9 14	6, 734, 315
New Jersey	117, 008	4 32	505, 475	212, 541	11 20	2, 380, 459
Pennsylvania	1, 749, 236	3 19	5, 580, 063	1, 092, 682	9 27	10, 129, 162
Delaware	22, 077	3 25	71, 750	45, 805	7 80	357, 279
Maryland	172, 022	3 33	572, 833	325, 413	7 54	2, 453, 614
Virginia	487, 194	2 58	1, 256, 961	820, 296	4 24	3, 478, 055
North Carolina	452, 176	1 38	624, 003	1, 364, 294	3 91	5, 334, 390
South Carolina	116, 476	1 67	194, 515	578, 755	4 18	2, 419, 196
Georgia	543, 415	1 50	815, 122	1, 582, 116	3 67	5, 806, 366
Florida	98, 940	1 75	173, 145	313, 600	2 14	671, 104
Alabama	343, 925	1 49	512, 448	1, 286, 811	3 17	4, 079, 191

Table showing the estimated numbers of animals on farms, total value of each kind, and average price, January, 1884—Continued.

States and Territories.	Sheep.			Hogs.		
	Number.	Average price.	Value.	Number.	Average price.	Value.
Mississippi	293, 477	$1 57	$460, 759	1, 177, 296	$3 29	$3, 873, 304
Louisiana	124, 984	1 67	208, 723	626, 527	3 78	2, 368, 272
Texas	7, 956, 275	2 24	17, 822, 056	2, 011, 785	3 82	7, 685, 019
Arkansas	227, 293	1 63	370, 488	1, 550, 636	3 58	5, 551, 277
Tennessee	655, 214	1 79	1, 172, 833	2, 127, 966	4 17	8, 873, 618
West Virginia	671, 226	2 61	1, 751, 900	424, 626	4 91	2, 084, 914
Kentucky	980, 166	2 63	2, 577, 837	1, 954, 919	4 92	9, 618, 201
Ohio	5, 000, 036	2 93	14, 650, 105	2, 442, 701	6 20	15, 144, 746
Michigan	2, 412, 422	3 01	7, 261, 390	840, 766	6 10	5, 128, 673
Indiana	1, 145, 084	2 81	3, 217, 686	2, 642, 652	6 15	16, 252, 310
Illinois	1, 126, 908	2 67	3, 008, 844	4, 010, 472	6 79	27, 231, 105
Wisconsin	1, 336, 403	2 38	3, 180, 639	1, 046, 014	6 08	6, 359, 765
Minnesota	275, 463	2 66	732, 732	411, 335	5 22	2, 147, 169
Iowa	497, 161	2 78	1, 382, 108	4, 800, 998	6 38	30, 630, 367
Missouri	1, 439, 380	2 00	2, 878, 760	4, 087, 566	4 74	19, 375, 063
Kansas	821, 709	2 30	1, 889, 931	2, 103, 725	7 03	14, 789, 187
Nebraska	333, 834	2 18	727, 758	1, 786, 383	7 29	13, 022, 732
California	6, 203, 064	1 90	11, 785, 822	950, 160	5 66	5, 377, 996
Oregon	2, 571, 378	1 81	4, 654, 194	184, 160	4 19	771, 630
Nevada	385, 350	2 06	793, 821	13, 200	8 40	110, 880
Colorado	1, 248, 360	2 16	2, 696, 458	12, 342	9 50	117, 249
Arizona	812, 700	2 00	1, 625, 400	9, 384	6 50	60, 996
Dakota	182, 000	2 71	493, 220	122, 752	6 80	834, 714
Idaho	187, 500	2 50	468, 750	24, 780	9 20	227, 976
Montana	465, 750	2 90	1, 350, 675	17, 544	9 28	162, 808
New Mexico	4, 435, 200	1 70	7, 539, 840	23, 353	8 04	187, 758
Utah	564, 300	2 30	1, 297, 890	24, 525	9 15	224, 404
Washington	456, 300	2 39	1, 090, 557	54, 827	7 73	423, 813
Wyoming	598, 000	2 18	1, 303, 640	....	....	....
Indian Territory	....	....	....	....	....	....
Total	50, 626, 626	2 37	119, 902, 706	44, 200, 893	5 57	246, 301, 139

CONDITION, DISEASES, AND LOSSES.

The health and condition of farm animals during the autumn of 1883–'84 have compared favorably with former years. Horses are best cared for, being most valuable and necessary for daily use in the work of the farm. Diseases are usually fewer and less fatal than in the case of cattle and swine. The disease known as pinkeye has prevailed more extensively than any other, with comparatively small mortality. Lung fever was occasionally reported. Glanders and other infectious diseases have been so carefully guarded against that their occurrence has been infrequent.

The reports concerning cattle are generally favorable, though the usual losses from exposure and lack of provision of feed in inclement weather have been reported from the South and distant West. In New England and the Middle States, where care and protection were universal, there has been little suffering or loss. There is more complaint of loss from neglect and scarcity in Virginia and the Carolinas, intensified by excess of rainfall, which increased the discomfort and loss. In the lower latitudes there had been drought and short pasturage in the autumn, and scanty winter feed was the rule over these dry areas, with much suffering and loss of cattle necessarily resulting. In Winston County, Mississippi, it was said that "not less than 2,000 died from want of proper pasturage." In Texas comparatively favorable returns were received, though some counties had been parched by drought.

In Missouri and Arkansas there were losses of cattle by overflows of rivers.

The condition of cattle on the plains and in the western mountain valleys was generally reported good. There was probably more loss in southern latitudes than in the more northern pasture grounds. In the Indian Territory losses from lack of pasturage and winter exposure were severe; 30,000 head, in the Cherokee territory alone, as is estimated, fell victims during the season.

LOSSES OF CATTLE.

The estimated losses of cattle from diseases of all kinds, stress of weather, theft, or other causes, are given in the following table:

States and Territories.	Milch cows, oxen, and other cattle.	Losses.	
		Per cent.	Number.
Maine	351, 014	2	7, 020
New Hampshire	236, 941	2	4, 739
Vermont	418, 250	2	8, 365
Massachusetts	268, 619	2	5, 372
Rhode Island	35, 309	2	706
Connecticut	234, 446	2	4, 689
New York	2, 396, 945	3	71, 908
New Jersey	234, 513	2	4, 690
Pennsylvania	1, 760, 435	3	52, 810
Delaware	54, 367	4	2, 175
Maryland	264, 342	3	7, 930
Virginia	682, 173	4	27, 287
North Carolina	653, 847	7	45, 769
South Carolina	354, 643	6	21, 279
Georgia	951, 859	7	66, 630
Florida	606, 054	8	48, 484
Alabama	759, 768	7	53, 184
Mississippi	695, 328	8	55, 626
Louisiana	425, 055	9	38, 255
Texas	4, 945, 201	6	296, 712
Arkansas	678, 628	5	33, 931
Tennessee	779, 826	5	38, 991
West Virginia	450, 897	3	13, 527
Kentucky	803, 608	3	24, 108
Ohio	1, 799, 816	2	35, 996
Michigan	895, 870	3	26, 876
Indiana	1, 356, 148	3	40, 684
Illinois	2, 343, 328	3	70, 300
Wisconsin	1, 218, 477	3	36, 464
Minnesota	770, 948	3	23, 128
Iowa	3, 040, 887	4	121, 635
Missouri	2, 009, 647	6	120, 579
Kansas	1, 922, 133	2	38, 443
Nebraska	1, 624, 044	4	64, 962
California	830, 208	7	58, 115
Oregon	601, 216	4	24, 049
Nevada	234, 389	4	9, 376
Colorado	815, 674	3	24, 470
Arizona	216, 057	6	12, 963
Dakota	346, 537	4	13, 861
Idaho	220, 612	4	8, 824
Montana	686, 839	4	27, 474
New Mexico	707, 305	5	35, 365
Utah	170, 653	7	11, 946
Washington	276, 008	4	11, 040
Wyoming	901, 533	4	36, 061
Indian Territory	520, 000	5	26, 000
Total	42, 547, 307	4.3	1, 812, 798

These animals are mainly lost by exposure to winter weather rather than by disease, and losses are most numerous in the regions of mild winter weather and in the pastoral or ranch belt. They are, therefore, of lower value than the average, and the heaviest losses are in regions of lowest valuation. At two-thirds the average value of cattle in January last, the loss would exceed $30,000,000.

PERCENTAGE OF HIGH-GRADE CATTLE.

The following table gives the total number of cattle, with the estimated percentage of high grades, or cattle of more than one-half pure blood of all breeds of thoroughbreds. It is not assumed to be absolutely correct; it may be difficult to obtain exact proportions by local estimates. It is, however, a fair consideration of the estimates of correspondents, made for each county respectively, and is entitled to be considered the result of the deliberate judgment of a body of practical farmers upon this important question:

States and Territories.	Total number of cattle.	High-grade cattle.	
		Per cent.	Number.
Maine	351, 014	25	87, 753
New Hampshire	236, 941	21	49, 758
Vermont	418, 250	20	83, 650
Massachusetts	268, 619	32	85, 958
Rhode Island	35, 309	34	12, 005
Connecticut	234, 446	31	72, 678
New York	2, 396, 945	20	479, 389
New Jersey	234, 513	18	42, 212
Pennsylvania	1, 760, 345	18	316, 862
Delaware	54, 367	18	9, 786
Maryland	264, 342	15	39, 651
Virginia	682, 173	14	95, 504
North Carolina	653, 847	11	71, 923
South Carolina	354, 643	10	35, 464
Georgia	951, 859	9	85, 667
Florida	606, 054	9	54, 545
Alabama	759, 768	8	60, 781
Mississippi	695, 328	8	55, 626
Louisiana	425, 055	7	29, 754
Texas	4, 945, 201	10	494, 520
Arkansas	678, 628	9	61, 077
Tennessee	779, 826	18	140, 369
West Virginia	450, 897	24	108, 215
Kentucky	803, 608	40	321, 443
Ohio	1, 799, 816	40	719, 926
Michigan	895, 870	19	170, 215
Indiana	1, 356, 148	33	447, 529
Illinois	2, 343, 328	35	820, 165
Wisconsin	1, 215, 477	16	194, 476
Minnesota	770, 948	12	92, 514
Iowa	3, 040, 887	21	638, 586
Missouri	2, 009, 647	20	401, 929
Kansas	1, 922, 133	21	403, 648
Nebraska	1, 624, 044	17	276, 087
California	830, 208	12	99, 625
Oregon	601, 216	13	78, 158
Nevada	234, 389	10	23, 439
Colorado	815, 674	12	97, 881
Arizona	216, 057	5	10, 803
Dakota	346, 537	15	51, 981
Idaho	220, 612	9	19, 855
Montana	686, 839	9	61, 815
New Mexico	707, 305	5	35, 365
Utah	170, 653	15	25, 598
Washington	276, 008	10	27, 601
Wyoming	901, 533	10	90, 153
Indian Territory	520, 000	8	41, 600
Total	42, 547, 307	18	7, 723, 539

IMPROVEMENT BY BREEDING.

An effort was made to indicate, roughly at least, the value of the improvement already attained by the introduction of European breeds during the progress of the experiment which is now in full tide of successful operation; of course it is difficult, and a close approximation may be impracticable at present, but the views of our practical reporters, properly consolidated, may be presumed to come near to the truth.

At least they are entitled to consideration and fair criticism, with the confident expectation of deriving some aid in the investigation of so important a subject as the value of the improvement made already by the breeders of the United States, which may prove an incentive to future effort.

The present value of cattle is taken as estimated in January last, which includes two elements, viz, the original value of the unimproved stock, and the percentage of improvement added by breeding. Thus, in Maine, the original value may be represented by 100, the improvement by 35, so that the present value is 135 per cent. of the unimproved value.

The average value of the improvement throughout the United States is also 35; therefore, of the present value of cattle, $1,106,715,703, the unimproved valuation would be $819,263,789, and the value of the improvement $287,451,916—added to the value of our cattle by infusion of superior blood during many years of judicious and scientific practice of enterprising breeders.

States and Territories.	Unimproved value.	Value of improvements.	Per cent.
Maine	$8, 624, 706	$3, 018, 647	35
New Hampshire	5, 898, 705	1, 946, 573	33
Vermont	9, 943, 807	3, 380, 895	34
Massachusetts	7, 356, 313	2, 574, 709	35
Rhode Island	995, 296	298, 589	30
Connecticut	6, 162, 322	1, 848, 696	30
New England	38, 981, 149	13, 068, 109	34
New York	62, 839, 938	25, 135, 975	40
New Jersey	7, 000, 223	2, 100, 067	30
Pennsylvania	44 289, 057	15, 944, 060	36
North Middle	114, 129, 218	43, 180, 102	38
Delaware	1, 394, 209	460, 089	33
Maryland	5, 905, 620	2, 303, 192	39
Virginia	10, 644, 501	3, 938, 466	37
South Middle	17, 944, 330	6, 701, 747	38
North Carolina	6, 463, 053	2, 068, 177	32
South Carolina	4, 166, 361	1, 458, 227	35
Georgia	10, 278, 634	3, 391, 949	33
Florida	4, 714, 937	1, 084, 435	23
Atlantic South	25, 622, 985	8, 002, 788	31
Alabama	7, 618, 827	2, 438, 025	32
Mississippi	7, 037, 677	2, 111, 303	30
Louisiana	4, 852, 641	1, 601, 372	33
Texas	67, 597, 260	23, 659, 041	35
Arkansas	8, 522, 295	2, 812, 357	33
Tennessee	11, 001, 057	4, 180, 401	38
Cotton States	106, 629, 757	36, 802, 499	35
West Virginia	8, 929, 861	3, 482, 646	39
Kentucky	16, 879, 011	6, 751, 604	40
Ohio	41, 776, 513	16, 710, 605	40
Indiana	29, 155, 854	11, 370, 783	39
Illinois	51, 782, 565	20, 195, 201	39
Iowa	60, 930, 182	24, 372, 073	40
Missouri	35, 570, 562	13, 516, 813	38
Kansas	39, 114, 629	16, 428, 144	42
Nebraska	31, 868, 637	12, 747, 455	40
Western Central	316, 007, 814	125, 575, 324	40
Michigan	21, 420, 947	7, 068, 913	33
Wisconsin	28, 192, 548	7, 330, 063	26
Minnesota	16, 351, 867	5, 396, 116	33
Lake States	65, 965, 362	19, 795, 092	30

States and Territories.	Unimproved value.	Value of improvements.	per cent.
California	$19,813,507	$6,340,322	32
Oregon	13,120,202	3,280,050	25
Nevada	5,439,031	1,087,806	20
Colorado	17,619,120	4,580,971	26
Arizona	3,899,437	584,915	15
Dakota	7,173,774	2,582,558	36
Idaho	4,931,937	986,388	20
Montana	15,101,716	3,020,343	20
New Mexico	12,417,372	1,986,779	16
Utah	3,550,356	958,596	27
Washington	5,958,152	1,429,956	24
Wyoming	18,158,563	5,447,571	30
Indian Territory	6,800,000	2,040,000	30
Rocky Mountain and Pacific Coast	133,983,172	34,326,255	26
Total	819,263,787	287,451,916	35

It should be understood, in examination of these figures, that the original unimproved stock of different sections were very unlike. In the Eastern and Middle States they were derived mainly from England and Holland. In the Atlantic States of the South from various parts of Europe. The Florida cattle are of Spanish origin; those of Texas, from Mexico, derived remotely from Spain. There is a vast difference between the English and Spanish stock, an immense distance between the long-horn and the short-horn type. Hence a given per cent. of improvement does not mean the same in Texas as in Illinois." It represents the advance made upon the original standard.

STOCK DISTRIBUTION.

The initial movement in American stock distribution may properly be reckoned the annual Texas drives, by which the surplus of overflowing Texas herds is sent to the Northern plains and the mountains of Colorado and Wyoming for development of yearlings and two-year-olds and for finishing of older cattle. In 1866 a drive that would be deemed very respectable in numbers occurred. In two years following few cattle were driven, owing to the opposition, sometimes amounting to resort to arms, of the settlers of Northwestern Missouri and Eastern Kansas, which was excited by heavy losses of native stock from the disease known as the Texas cattle fever. The numbers annually driven northward according to the record of the Kansas City Board of Trade, have been as follows:

Year.	Amount.	Year.	Amount.	Year.	Amount.
1866	260,000	1872	350,000	1878	265,646
1867	35,000	1873	405,000	1879	257,927
1868	75,000	1874	166,000	1880	394,789
1869	350,000	1875	151,618	1881	250,000
1870	300,000	1876	321,998	1882	250,000
1871	600,000	1877	201,159	1883	267,000

The movement of stock at Kansas City has been a marvelous growth. From receipts of 4,200 cattle in 1868, 4,450 in 1869, and 21,000 in 1870, the increase has been rapid, rising to 460,598 in 1883. The movement of hogs has been equally rapid. There has also been a constant in-

crease in the movement of sheep, though less in volume. The receipts and shipments are thus recorded:

Entire movement of live stock.

Year.	Received.			Shipped.		
	Cattle.	Hogs.	Sheep.	Cattle.	Hogs.	Sheep.
1871	120,000	41,036	4,527	100,481	1,379	3,863
1872	236,802	104,689	6,071	206,467	8,593	5,401
1873	227,669	220,956	5,975	182,245	33,610	4,298
1874	207,069	212,532	8,875	166,519	114,569	6,976
1875	181,114	59,413	24,987	126,262	15,790	17,742
1876	183,378	153,777	55,045	120,040	26,264	22,[illegible]
1877	215,768	192,645	42,190	126,570	15,073	28,229
1878	175,344	427,777	36,700	131,761	91,671	30,[illegible]
1879	211,415	588,908	61,684	155,831	208,851	47,[illegible]
1880	244,709	676,477	50,611	194,421	152,920	[illegible]
1881	285,863	1,014,304	79,924	223,989	195,524	61,078
1882	439,671	963,036	80,724	359,012	191,325	52,652
1883	460,598	1,379,005	119,180	387,598	313,879	61,979

The last year's movement of horses and mules amounted to 19,860.

Of the total number of 460,780 cattle received in 1883, 177,657 came via the Atchison, Topeka and Santa Fé Railroad. The Missouri Pacific Railroad brought the largest number of hogs, 419,354 of the total 1,379,401. The larger shipments of cattle were by the Hannibal and Saint Joseph and the Chicago and Alton roads. The receipts of last year were brought by the following routes:

Route.	Cattle.	Hogs.	Sheep.	Horses and mules.
Hannibal and Saint Joseph Railroad	6,576	89,912	4,926	444
Wabash, Saint Louis and Pacific Railroad	9,907	15,138	2,441	575
Missouri Pacific Railroad	43,785	419,354	16,031	4,396
Union Pacific Railroad (Kansas Division)	45,601	102,036	17,038	565
Kansas City, Leavenworth and Southern Kansas Railroad	94,339	155,610	17,478	706
Kansas City, Fort Scott and Gulf Railroad	29,605	118,464	8,550	610
Kansas City, Saint Joseph and Council Bluffs Railroad	14,880	235,077	7,699	405
Atchison, Topeka and Santa Fé Railroad	177,651	178,753	26,798	1,720
Chicago and Alton Railroad	6,177	26,676	3,178	521
Chicago, Rock Island and Pacific Railroad	13,433	10,469	933	300
Driven in yards	13,757	22,912	14,598	9,516
Total	460,780	1,379,401	119,665	19,860

CHICAGO MOVEMENT.

Twenty years ago the receipts of cattle at Chicago were about a third of a million annually. In 1876 the aggregate exceeded a million, and it has now become nearly two millions. Sheep are distributed in smaller numbers. The sources of supply are indicated by the roads that bring them in, as shown by the following table:

RECEIPTS.

How received.	Cattle.	Sheep.
Chicago and Northwestern Railway	251,788	142,738
Illinois Central Railroad	97,407	39,966
Chicago, Rock Island and Pacific Railroad	271,411	56,816
Chicago, Burlington and Quincy Railroad	555,295	201,551
Chicago, Alton and Saint Louis Railroad	214,605	80,185
Chicago and Eastern Illinois Railroad	25,394	9,915
Chicago, Milwaukee and Saint Paul Railway	253,243	160,222
Wabash, Saint Louis and Pacific Railway	180,526	46,966
Louisville, New Albany and Chicago Railroad	10,780	2,804

RECEIPTS—Continued.

How received.	Cattle.	Sheep.
Michigan Central Railroad	1,741	6,470
Lake Shore and Michigan Southern Railway	2,014	7,311
Pittsburgh, Fort Wayne and Chicago Railway	2,161	937
Chicago, Saint Louis and Pittsburgh Railway	3,666	2,909
Baltimore and Ohio Railroad	1,397	3,749
Chicago and Grand Trunk Railway	1,104	3,332
New York, Chicago and Saint Louis Railroad	757	2,042
Chicago and Atlantic Railroad	634	799
Driven into yards	5,132	2,275
Total receipts	1,878,944	749,917

SHIPMENTS.

How shipped.	Cattle.	Sheep.
Chicago and Northwestern Railway	12,818	5,969
Illinois Central Railroad	13,601	613
Chicago, Rock Island and Pacific Railroad	20,285	1,125
Chicago, Burlington and Quincy Railroad	6,354	1,798
Chicago, Alton and Saint Louis Railroad	11,514	4,076
Chicago and Eastern Illinois Railroad	5,679	509
Chicago, Milwaukee and Saint Paul Railway	8,069	5,998
Wabash, Saint Louis and Pacific Railway	5,265	3,374
Louisville, New Albany and Chicago Railroad	4,979	110
Michigan Central Railroad	209,504	5,801
Lake Shore and Michigan Southern Railway	228,585	127,838
Pittsburgh, Fort Wayne and Chicago Railway	157,976	117,089
Chicago, Saint Louis and Pittsburgh Railway	95,657	2,561
Baltimore and Ohio Railroad	48,758	5,797
Chicago and Grand Trunk Railway	6,692	824
New York, Chicago and Saint Louis Railroad	83,997	63,248
Chicago and Atlantic Railroad	47,546	27,733
Total shipments	966,758	374,463
City consumption and packing	912,186	375,454
	1,878,944	749,917

The movement is distributed through the year, but is most active from July to January, the heaviest movement occurring in the early autumn.

The movement of hogs, live and dressed, as reported by the Union Stock Yards Company, is as follows:

RECEIPTS.

How received.	Live.	Dressed.
Chicago and Northwestern Railway	1,120,259	9,936
Illinois Central Railroad	515,450	13,037
Chicago, Rock Island and Pacific Railroad	773,291	289
Chicago, Burlington and Quincy Railroad	1,375,723	822
Chicago, Alton and Saint Louis Railroad	328,202	134
Chicago and Eastern Illinois Railroad	77,599	25
Chicago, Milwaukee and Saint Paul Railway	952,229	30,126
Wabash, Saint Louis and Pacific Railway	263,068	48
Louisville, New Albany and Chicago Railroad	20,824	14
Michigan Central Railroad	54,805	220
Lake Shore and Michigan Southern Railway	45,842	136
Pittsburgh, Fort Wayne and Chicago Railway	22,074	552
Chicago, Saint Louis and Pittsburgh Railway	88,083	421
Baltimore and Ohio Railroad	20,525	75
Chicago and Grand Trunk Railway	14,952	30
New York, Chicago and Saint Louis Railroad	8,248	666
Chicago and Atlantic Railroad	8,014	7
Driven into yards	1,437	....
Total live	5,640,625	....
Total dressed	....	56,538
Total live and dressed	....	5,697,163

SHIPMENTS.

How shipped.	Live.	Dressed.
Chicago and Northwestern Railway	4,353	65
Illinois Central Railroad	908	....
Chicago, Rock Island and Pacific Railroad	1,895	....
Chicago, Burlington and Quincy Railroad	1,832	....
Chicago, Alton and Saint Louis Railroad	209	....
Chicago and Eastern Illinois Railroad	6	....
Chicago, Milwaukee and Saint Paul Railway	278	....
Wabash, Saint Louis and Pacific Railway	647	....
Louisville, New Albany and Chicago Railroad	9	....
Michigan Central Railroad	394,371	11,7[illegible]
Lake Shore and Michigan Southern Railway	536,175	28,2[illegible]
Pittsburgh, Fort Wayne and Chicago Railway	202,443	2,1[illegible]
Chicago, Saint Louis and Pittsburgh Railway	783	711
Baltimore and Ohio Railroad	9,946	1,[illegible]
Chicago and Grand Trunk Railway	19,643	31[illegible]
New York, Chicago and Saint Louis Railroad	126,509	....
Chicago and Atlantic Railroad	18,386	....
Total live	1,319,392	....
Total dressed	....	44,367
Total live and dressed	....	1,363,759
Left for city use and packing	....	4,233,404
		5,597,163

BUFFALO.

The receipts and shipments of live stock at Buffalo in 1883 were as follows:

Stock.	Receipts.	Shipment.
Cattle	563,520	523,8[illegible]
Sheep	791,100	682,9[illegible]
Hogs	2,063,200	1,562,0[illegible]

SEABOARD CITIES.

At the seaboard the movement was represented by the following figures:

At—	Cattle.	Sheep.	Hogs.	Veals.	Total.
New York	674,632	2,036,018	1,586,243	190,327	4,487,220
Boston	161,163	648,790	771,757	39,712	1,621,421
Philadelphia	236,050	680,417	383,312	....	1,299,779
Baltimore	94,349	198,060	271,148	....	563,557
Total	1,166,193	3,563,285	3,012,460	230,039	7,971,977

SHIPMENTS ABROAD.

The exportation of stock has received a great impetus the past year. Between 1870 and 1873, the valued annual exports of cattle did not average half a million dollars; those of 1883–'84 were valued at $17,855,495. In fourteen years the numbers increased from 27,530 to 190,518. There has also been a large increase in exports of sheep. The statement is as follows:

Year.	Cattle.		Swine.		Sheep.		Horses.		Mules.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
1870	27,530	$439,987	12,058	$189,753	39,570	$95,193	2,121	$177,479	995	$140,350
1871	20,530	403,491	8,770	61,390	45,465	86,888	1,186	173,273	1,930	265,827
1872	28,033	565,719	56,110	548,153	35,218	79,592	1,722	268,475	2,121	294,402
1873	35,455	695,957	99,720	787,402	66,717	107,698	2,814	255,365	1,659	172,172
1874	56,067	1,150,857	158,581	1,625,837	124,248	150,735	1,432	169,303	1,252	174,125
1875	57,211	1,103,085	64,979	739,215	124,416	183,898	3,220	242,031	2,802	356,828
1876	51,593	1,110,703	68,044	670,042	110,312	171,101	2,030	234,964	1,784	224,860
1877	50,001	1,593,080	65,107	699,180	179,017	234,480	2,042	301,134	3,441	478,434
1878	80,040	3,896,818	29,284	267,259	183,995	333,499	4,104	798,723	3,860	501,513
1879	136,720	8,379,200	75,129	700,262	215,680	1,082,938	3,915	770,742	4,153	530,989
1880	182,756	13,344,195	83,434	421,089	209,137	892,647	3,060	675,139	5,198	532,362
1881	185,707	14,304,103	77,456	572,138	179,919	762,932	2,523	390,243	3,207	353,924
1882	108,110	7,800,227	36,368	509,651	139,676	603,778	2,248	470,183	2,632	320,130
1883	104,444	8,341,431	16,129	272,516	337,251	1,154,856	2,800	475,806	4,237	486,560
1884	190,518	17,855,495	46,382	627,480	273,874	850,146	2,721	424,317	3,742	490,809

The exports of cattle, in number and value, last year, exceeded those of any previous exportation, 169,257 going to Great Britain, valued at $17,336,606. A noticeable feature of the record is the small number shipped to Cuba. There has been a decline annually from 49,228 in 1879 to 8,015 last year. The distribution by countries is as follows:

Countries to which exported.	1879.	1880.	1881.	1882.	1883.	1884.
	Number.	*Number.*	*Number.*	*Number.*	*Number.*	*Number.*
England	68,544	118,242	124,317	61,876	67,013	150,686
Scotland	3,250	7,275	9,744	6,132	9,078	18,571
Germany	1,330	....	207	6	....	323
Belgium	1,816	3,342	2,093	....	189	....
France	118	1,240	1,297	110	....	....
Cuba	49,228	45,515	38,941	34,603	20,784	8,015
British West Indies and Honduras	1,531	2,409	1,978	1,531	1,174	1,163
Dominion of Canada	8,555	2,840	4,658	2,803	3,821	3,475
Mexico	2,145	992	1,254	793	1,812	8,093
Other countries	203	901	1,218	256	573	192
Total	136,720	182,756	185,707	108,110	104,444	190,518

The imports of domestic animals in the year ended June 30, 1884, in numbers and value, are thus reported in the official statistics of the customs:

Stock.	Number.	Value.
Cattle	99,769	3,103,781
Horses	45,610	3,726,584
Sheep	298,275	891,390

They are introduced mainly for improvement of breeds. Those that pay duty are stockers, or young cattle, from Mexico and Canada.

The dutiable imports of horses were also from Canada and Mexico mainly, 46 coming from Great Britain, 59 from the British West Indies, 26 from Cuba, and only 6 from other countries.

The dutiable sheep imported also came from Canada, except 5,099 from Mexico, and a few from the West Indies.

The average value of imports were:

Stock.	Free.	Dutiable.
Cattle	56.31	12.51
Horses	121.10	55.38
Sheep	16.84	2.78

The aggregate of duty-free cattle may leave a false impression if assumed to represent superior blood introduced to improve the breed of American cattle. It is 41,021, of which 29,592 are from Mexico, and worth only $14.13, while the remainder, 11,429 animals, were entered at the value of $1,891,846, or $165.53 per head. It may be deemed a violation of the spirit of the law, as the purpose is to obtain the cheap cattle of Mexico; by the introduction of cows "for breeding purposes," to get cheap calves for ranch-stocking by cross-breeding with better stock.

The horses come mainly from Canada and France. The importation from the latter country is mainly Normans or Percherons. More than half are from Mexico, valued at little more than $8 per head. These are for "breeding purposes," but not for improvement of our horses; they are bought because they are cheap, to be bred up into better blood and greater value.

The principal sources of these supplies are as follows:

From—	Cattle.		Horses.		Sheep.	
	Number.	Value.	Number.	Value.	Number.	Value.
Belgium	645	$47,735	54	$47,226		
France	121	9,512	1,007	586,216	104	$11,330
Germany	8	957	2	238	5	2,209
England	3,300	814,910	372	152,123	98	4,150
Scotland	135	33,625	418	148,589		
Dominion of Canada	4,643	773,269	5,183	1,183,101	2,684	31,605
Australasia	34	13,213			120	24,155
Mexico	29,592	418,104	11,224	92,085	1,416	1,118
Netherlands	2,527	196,325				
Other countries	16	2,300	11	3,013		
Total	41,021	2,309,950	18,271	2,212,591	4,427	74,588

PROPORTION OF BREEDS IMPORTED.

The records of the Bureau of Animal Industry of this Department show the breed of all animals imported, and the residence of the importer to whom the permit is given. In the five months from July 1 to December 1, 1884, there were 1,688 animals received in quarantine under permits to persons in thirteen States. Much the larger portion are the dairy breeds, 1,235 Holsteins, and 198 Jerseys. The former were all credited to the Eastern and Middle States, except 76 to Kentucky, 43 to California, 35 to Mississippi, and 7 to Wisconsin. There were 92 Galloways, 70 Herefords, and 72 Guernseys. The country is so well

supplied with Short-horns that importation of 2 only are reported. The summary of the record is as follows:

States.	Angus.	Galloway.	Jersey.	Guernsey.	Hereford.	Holstein.	Short horn.	Sussex.	Total.
California						43			43
Connecticut						100			100
Illinois					20				20
Kentucky						76			76
Maryland			25						25
Massachusetts	*8	*92				297	2		399
Mississippi						35			35
Missouri					50				50
New Jersey			11			42			53
New York			69			601			670
Pennsylvania			93	72		34			199
Tennessee								11	11
Wisconsin									7
Total	8	92	198	72	70	1,235	2	11	1,688

* From Scotland—destination unknown.

CORN.

DOMESTIC CONSUMPTION.

The rate of consumption of corn differs in accordance with its uses and with climate. If used for meat-making, it is consumed as early as possible before the severity of winter weather interferes with fattening. That fed to hogs is thus disposed of mainly before Christmas. When used mainly for feeding work animals, as in the South, it is fed throughout the year, and the season of hardest work is the planting season, from March to July. Hence it is found that two-thirds of the supply has been used or sold in the West by the 1st of March, while in the South nearly half is still on hand at that date.

The investigation of March, 1883, showed a reduction of stock on hand of 40,000,000 bushels in the States of Ohio, Indiana, Illinois, and Iowa, as compared with the stock of the previous March. The total difference in the aggregate stocks of the two seasons for the whole country was 75,000,000 bushels, while the difference in the production of the two years was 66,000,000 bushels. The feeding value of the crop of 1883 was less, and its consumption was therefore greater, despite the economy enforced by higher prices. The comparison of the two seasons is thus compared:

Sections.	Stock on hand March 1—			
	1883.		1884.	
	Bushels.	Per cent.	Bushels.	Per cent.
New England	1,898,701	29.8	2,843,390	33.8
Middle	29,397,288	37.4	21,890,705	31.8
Southern	171,551,062	43.5	137,922,030	41.4
Western	381,600,606	33.8	346,771,467	30.7
Pacific	735,734	25.4	760,128	29.3
Nevada, Colorado, and Territories	2,282,552	35.0	2,036,281	29.8
Total	587,465,943	36.3	512,224,003	33.0

The statement by individual States is as follows:

CORN.

States and Territories.	Product in 1883.	Stock on hand March 1, 1884.		Retained for county consumption.		Distribution beyond county lines.		Remaining in field.
	Bushels.	*Bushels.*	*P. ct.*	*Bushels.*	*P. ct.*	*Bushels.*	*P. ct.*	*P. ct.*
Maine	1,062,800	393,236	37	1,052,172	99	10,628	1	......
New Hampshire	1,368,500	506,345	37	1,354,815	99	13,685	1	......
Vermont	1,817,300	636,055	35	1,799,127	99	18,173	1	......
Massachusetts	2,039,100	632,121	31	2,039,100	100	....	......	......
Rhode Island	414,300	128,433	31	414,300	100	....	......	......
Connecticut	1,710,000	547,200	32	1,710,000	100	....	......	2
New York	17,512,700	4,903,556	28	17,162,446	98	350,254	2	1
New Jersey	9,715,100	4,177,493	43	8,452,137	87	1,262,963	13	......
Pennsylvania	37,857,400	11,357,220	30	34,071,660	90	3,785,740	10	4
Delaware	3,822,200	1,452,436	38	2,981,316	78	840,884	22	6
Maryland	16,251,200	7,150,528	44	12,188,400	75	4,062,800	25	3
Virginia	26,868,700	11,553,541	43	23,644,456	88	3,224,244	12	11
North Carolina	28,692,200	12,337,647	43	25,822,980	90	2,869,220	10	......
South Carolina	11,107,800	3,887,730	35	10,885,644	98	222,156	2	......
Georgia	24,615,900	10,338,678	42	23,138,946	94	1,476,954	6	......
Florida	3,399,200	1,495,648	44	3,195,248	94	203,952	6	......
Alabama	26,189,300	12,047,078	46	25,141,728	96	1,047,572	4	......
Mississippi	25,257,100	10,607,982	42	24,751,958	98	505,142	2	......
Louisiana	13,130,600	4,727,016	36	13,130,600	100	....	......	......
Texas	63,146,300	25,889,983	41	53,042,892	84	10,103,408	16	......
Arkansas	30,456,500	12,182,600	40	28,933,675	95	1,522,825	5	10
Tennessee	64,259,000	25,703,600	40	52,049,790	81	12,209,210	19	4
West Virginia	14,294,000	4,288,200	30	13,150,480	92	1,143,520	8	7
Kentucky	78,201,800	24,242,558	31	65,689,512	84	12,512,288	16	8
Ohio	73,560,000	15,447,600	21	66,939,600	91	6,620,400	9	4
Michigan	21,412,300	3,425,968	16	19,271,070	90	2,141,230	10	5
Indiana	95,620,000	28,686,000	30	76,496,000	80	19,124,000	20	8
Illinois	203,786,500	61,113,505	30	150,802,010	74	52,984,490	26	8
Wisconsin	23,579,300	3,536,895	15	23,107,714	98	471,586	2	7
Minnesota	15,124,800	2,722,464	18	14,822,304	98	302,496	2	10
Iowa	169,629,000	40,710,960	24	156,058,680	92	13,570,320	8	7
Missouri	161,655,000	48,496,500	30	137,406,750	85	24,248,250	15	9
Kansas	172,800,900	72,576,378	42	77,760,405	45	95,040,495	55	6
Nebraska	101,278,900	41,524,349	41	59,754,551	59	41,524,349	41	12
California	2,464,800	739,440	30	2,267,616	92	197,184	8	......
Oregon	129,300	20,688	16	125,421	97	3,879	3	......
Nevada	21,100	3,798	18	18,990	90	2,110	10	......
Colorado	532,100	186,235	35	441,643	83	90,457	17	......
Arizona	54,700	19,145	35	54,700	100	....	......	......
Dakota	4,915,055	1,474,516	30	4,767,603	97	147,452	3	14
Idaho	32,500	....	......	32,500	......	....	......	......
Montana	10,040	3,715	37	9,538	95	502	5	......
New Mexico	930,100	260,428	28	837,090	90	93,010	10	......
Utah	280,100	70,025	25	235,284	84	44,816	16	......
Washington	61,400	18,420	30	49,120	80	12,280	20	......
Total	1,551,066,895	512,224,003	33	1,237,061,971	79.8	314,004,924	20.2	......

The different divisions of country share as follows in the above distribution:

Sections.	Crop of 1883.	Stock on hand March 1, 1884.		Retained for county consumption.		Distribution beyond county lines.	
	Bushels.	*Bushels.*	*P. ct.*	*Bushels.*	*P. ct.*	*Bushels.*	*P. ct.*
New England	8,412,000	2,843,390	33.8	8,369,514	99.5	42,486	0.5
Middle	68,907,400	21,890,705	31.8	62,667,559	90.9	6,239,841	9.1
Southern	333,373,800	137,922,031	41.4	295,926,317	88.8	37,447,483	11.2
Western	1,130,942,500	346,771,467	30.7	861,259,076	76.2	269,683,424	23.8
Pacific	2,594,100	760,128	29.3	2,393,037	92.2	201,063	7.8
Nevada, Colorado, and Territories	6,837,095	2,036,282	29.8	6,446,468	94.3	390,627	5.7
Total	1,551,066,895	512,224,003	33.0	1,237,061,971	79.8	314,004,924	20.2

It will be seen that the reduction of farm stocks as compared with March, 1883, is very heavy in the northern belt of States—from New York to Minnesota. In the surplus-corn States, the seven from Ohio to

Kansas, inclusive, from which comes the corn of commercial distribution, the difference in quantity on hand is not very heavy, while Ohio is credited with little more than half as much as in March, 1883, and Illinois and Indiana, as well as Iowa, have reduced stocks; the increase in Kansas is 25,000,000 bushels. As most of the commercial corn in recent years has come from beyond the Mississippi, the effect of the Kansas and Nebraska surplus is to cheapen the price. So we see that No. 2 mixed was quoted in Chicago on the 1st of March at 53 cents, and in March of 1883 at 56 cents; in Cincinnati, 52 and 56, respectively. In Saint Louis the prices were lower, 49 to 53. In Kansas City, near the heart of the supply, the price is 5 cents lower than in March, 1883—40 cents instead of 45.

In studying crop returns the ever-recurring error of statisticians, for every man is his own statistician nowadays, is the assumption that the crop of the country is controlled by what appears under his own local horizon. The Michigan man therefore thinks there is no sound corn in the country; the Kansas man may naturally assume that the last was one of the greatest crops of record. The following statement shows what the estimates of the two years make the stock of March in the corn-surplus States:

States.	Stock on hand March 1—			
	1883.		1884.	
	Bushels.	Per cent.	Bushels.	Per cent.
Ohio	27,062,568	29	15,447,600	21
Indiana	38,694,348	36	28,686,000	30
Illinois	67,464,653	37	61,113,595	30
Iowa	52,646,280	30	40,710,960	24
Missouri	51,011,100	30	48,496,500	30
Kansas	47,669,358	33	72,576,378	42
Nebraska	35,465,626	43	41,524,349	41
Total	320,013,933	33	308,555,382	31.5

Prices of corn tell the true story of supply. In March, 1881, the price in Chicago was 37 cents when these seven States had a stock of 413,000,000 bushels remaining. But in March, 1882, after the disastrous failure of 1881, the price was 60 cents, with a stock of 200,000,000 bushels. In March, 1884, the price was 53 cents, showing that the quantity, in view of the poor quality of a large proportion of unmerchantable grain, was greatly in excess of the stocks of March, 1882, after the crop failure of 1881.

PROPORTION MERCHANTABLE.

It is proper to place on record the fact that the proportion of immature corn was twice as large as usual. The frosts of September, 1883, played havoc with the corn of the northern belt, a condensed statement of the results of which may be found in the following table of quantities of merchantable and unmerchantable corn. In no State is the crop of any year perfect. There is a considerable quantity of immature growth, the result of drought, floods, impoverished soil, bad cultivation or no cultivation. In northern regions there is always some loss of late-planted corn from frosts. The proportion of the crop of 1883 reported

merchantable was three-fifths of the whole; the proportion in an aver age year is four-fifths. In the March report it was said:

The extent of this disaster by frost is so sweeping that the aggregate of sound corn would not be materially lessened if all in the northern belt of States should be counted unmerchantable. In Maine, New Hampshire, Vermont, New York, Michigan, Wisconsin, and Dakota the merchantable amounts to only 21,000,000 bushels. If all should be called unsound it would still leave the aggregate 915,000,000. So severe is the damage that the great corn States, Illinois, Iowa, Indiana, and Ohio, which produce more than a third of the national crop, only report 35 per cent. of sound corn. If we should say that not a bushel of sound corn was grown north of Ohio River, from the Alleghenies to the Missouri, the aggregate would still be 723,000,000 bushels merchantable.

The extent of the injury is shown by the price, the unmerchantable averaging 27.2, the merchantable 51.4, cents per bushel. It will be seen from the statement that five-sixths of all the damaged corn is found north of the Ohio River, and west of Pennsylvania.

States and Territories.	Merchantable.			Unmerchantable.		
	Bushels.	Price per bushel.	Value.	Bushels.	Price per bushel.	Value.
Maine	669, 564	$0 83	$555, 738	393, 236	$0 45	$176, 956
New Hampshire	999, 005	85	849, 154	369, 495	43	158, 883
Vermont	1, 108, 553	82	909, 013	708, 747	41	290, 586
Massachusetts	1, 427, 370	79	1, 127, 622	611, 730	35	214, 105
Rhode Island	327, 297	85	278, 202	87, 003	42	36, 541
Connecticut	1, 282, 500	75	961, 875	427, 500	35	149, 625
New York	6, 129, 445	71	4, 351, 906	11, 383, 255	30	3, 414, 976
New Jersey	7, 674, 929	65	4, 988, 704	2, 040, 171	30	612, 051
Pennsylvania	20, 064, 422	66	13, 242, 519	17, 792, 978	31	5, 515, 823
Delaware	3, 478, 202	55	1, 913, 011	343, 998	40	137, 599
Maryland	13, 000, 960	57	7, 410, 547	3, 250, 240	28	910, 067
Virginia	18, 808, 090	68	12, 789, 501	8, 060, 610	35	2, 821, 213
North Carolina	22, 379, 916	83	18, 575, 330	6, 312, 284	44	2, 777, 405
South Carolina	9, 997, 020	85	8, 497, 467	1, 110, 780	48	533, 174
Georgia	21, 908, 151	80	17, 526, 521	2, 707, 749	42	1, 137, 255
Florida	3, 093, 272	90	2, 783, 945	305, 928	39	119, 312
Alabama	22, 522, 798	76	17, 117, 326	3, 666, 502	47	1, 723, 256
Mississippi	23, 236, 532	77	17, 892, 130	2, 020, 568	47	949, 667
Louisiana	11, 817, 540	73	8, 626, 804	1, 313, 000	48	630, 269
Texas	57, 463, 133	65	37, 351, 036	5, 683, 167	41	2, 330, 098
Arkansas	26, 192, 590	63	16, 501, 332	4, 263, 910	32	1, 364, 451
Tennessee	57, 190, 510	61	34, 886, 211	7, 068, 490	28	1, 979, 177
West Virginia	8, 862, 280	68	6, 026, 350	5, 431, 720	36	1, 955, 419
Kentucky	64, 125, 476	48	30, 780, 228	14, 076, 324	28	3, 941, 371
Ohio	27, 952, 800	58	16, 212, 624	45, 607, 200	23	10, 489, 656
Michigan	3, 854, 214	60	2, 312, 528	17, 558, 086	29	5, 091, 845
Indiana	46, 853, 800	48	22, 489, 824	48, 766, 200	26	12, 679, 212
Illinois	73, 363, 140	43	31, 546, 150	130, 423, 300	28	36, 518, 541
Wisconsin	4, 008, 481	54	2, 164, 580	19, 570, 819	28	5, 479, 829
Minnesota	2, 419, 968	48	1, 161, 585	12, 704, 832	23	2, 922, 111
Iowa	44, 103, 540	41	18, 082, 451	25, 525, 460	25	31, 381, 365
Missouri	96, 993, 000	42	40, 737, 060	64, 662, 000	27	17, 458, 740
Kansas	158, 976, 828	35	55, 641, 890	13, 824, 072	25	3, 456, 018
Nebraska	67, 856, 863	29	19, 678, 490	33, 422, 037	21	7, 018, 628
California	2, 267, 616	92	2, 086, 207	197, 184	67	132, 113
Oregon	106, 026	81	85, 881	23, 274	60	13, 964
Nevada	16, 880	80	13, 504	4, 220	50	2, 110
Colorado	441, 643	90	397, 479	90, 457	89	80, 507
Arizona	43, 760	1 20	52, 512	10, 940	95	10, 393
Dakota	1, 867, 721	74	1, 382, 114	3, 047, 334	29	883, 727
Montana	6, 727	1 25	8, 409	3, 313	50	1, 656
New Mexico	734, 779	72	529, 041	195, 321	37	72, 269
Utah	224, 080	73	163, 578	56, 020	42	23, 528
Washington	49, 120	95	46, 664	12, 280	50	6, 140
Total	935, 900, 541	51.4	480, 735, 043	615, 133, 854	27.2	167, 601, 631

WHEAT ON HAND.

The crop of 1883 was so small that especial interest was manifested in the returns of stock on hand in March, in comparison with similar investigations in former years. The returns estimate wheat in the lands

of farmers, and not in grain-elevators. They showed a reduction of 24,000,000 bushels in quantity, though the percentage of the crop was nearly the same as the previous year's remainder of the largest crop of 1882.

The statement by groups of States is as follows:

Sections.	Crop of 1883.	Stock on hand March 1, 1884.		Consumed in county where grown.		Shipped out of the county.	
	Bushels.	*Bushels.*	*Per ct.*	*Bushels.*	*Per ct.*	*Bushels.*	*Per ct.*
New England	1, 203, 700	504, 841	41. 9	1, 194, 020	99. 2	9, 680	00. 8
Middle	31, 109, 300	10, 715, 214	34. 4	18, 910, 643	60. 8	12, 198, 657	39. 2
Southern	38, 682, 900	9, 860, 380	25. 5	22, 225, 674	57. 5	16, 457, 226	42. 5
Northwestern	274, 411, 000	81, 336, 149	29. 6	111, 007, 314	40. 5	163, 403, 686	59. 5
Pacific	49, 444, 400	10, 948, 088	22. 1	13, 380, 440	27. 1	36, 063, 960	72. 9
Colorado, Dakota, and Territories	25, 303, 200	5, 908, 340	23. 4	8, 932, 694	35. 3	16, 370, 506	64. 7
Total	420, 154, 500	119, 273, 012	28. 4	175, 650, 785	41. 4	244, 503, 715	58. 2

The wheat on hand in March and the previous years' crops are thus reported:

Date.	Crop.	Stock on hand.
March 1, 1884	421, 000, 000	119, 000, 000
March 1, 1883	504, 000, 000	143, 000, 000
March 1, 1882	383, 000, 000	98, 000, 000
March 1, 1881	498, 000, 000	145, 000, 000

The statement of stock on hand, and also the proportion usually consumed or manufactured in the county, and that shipped out of the county is given as follows:

States and Territories.	Crop of 1883.	Stock on hand March 1, 1884.		Consumed in county where grown.	Shipped from county where grown.
	Bushels.	*Bushels.*	*Per ct.*	*Bushels.*	*Bushels.*
Maine	614, 300	215, 005	35	608, 157	6, 143
New Hampshire	181, 700	85, 399	47	181, 700	....
Vermont	353, 700	183, 924	52	350, 163	3, 537
Massachusetts	19, 700	6, 107	31	19, 700	....
Rhode Island	....	....	......	....	....
Connecticut	34, 300	14, 406	42	34, 300	....
New York	8, 035, 200	2, 892, 672	36	4, 821, 120	3, 214, 080
New Jersey	2, 063, 600	536, 536	26	1, 485, 792	577, 808
Pennsylvania	20, 043, 800	7, 015, 330	35	12, 226, 718	7, 817, 082
Delaware	966, 700	270, 676	28	377, 013	589, 687
Maryland	7, 577, 000	2, 045, 790	27	2, 045, 790	5, 531, 210
Virginia	8, 352, 800	2, 004, 672	24	3, 341, 120	5, 011, 680
North Carolina	4, 230, 800	1, 311, 548	31	3, 553, 872	676, 928
South Carolina	1, 136, 200	340, 860	30	1, 113, 476	22, 724
Georgia	2, 574, 900	669, 474	26	2, 137, 167	437, 733
Florida	....	....	......	....	....
Alabama	1, 437, 500	373, 750	26	1, 380, 000	57, 500
Mississippi	247, 500	49, 500	20	245, 025	2, 475
Louisiana	....	....	......	....	....
Texas	4, 301, 000	989, 230	23	3, 182, 740	1, 118, 260
Arkansas	1, 416, 400	297, 444	21	1, 373, 908	42, 492
Tennessee	7, 408, 800	1, 778, 112	24	3, 852, 576	3, 556, 224
West Virginia	4, 257, 000	1, 277, 100	30	2, 937, 330	1, 319, 670
Kentucky	9, 612, 600	1, 922, 520	20	4, 325, 670	5, 286, 930
Ohio	25, 884, 000	7, 506, 360	29	9, 577, 080	16, 306, 920
Michigan	25, 011, 000	6, 752, 970	27	8, 003, 520	17, 007, 480
Indiana	28, 447, 800	7, 396, 428	26	10, 810, 164	17, 637, 636
Illinois	22, 150, 000	4, 430, 000	20	9, 524, 500	12, 625, 500
Wisconsin	19, 604, 900	7, 449, 862	38	7, 253, 813	12, 351, 087
Minnesota	33, 773, 200	13, 509, 280	40	9, 118, 764	24, 654, 436
Iowa	27, 518, 800	9, 356, 392	34	19, 538, 348	7, 980, 452
Missouri	23, 819, 300	5, 716, 632	24	9, 527, 720	14, 291, 580

States and Territories.	Crop of 1883.	Stock on hand March 1, 1884.		Consumed in county where grown.	Shipped from county where grown.
	Bushels.	*Bushels.*	*Per. ct.*	*Bushels.*	*Bushels.*
Kansas	26,851,100	8,323,841	31	9,397,885	17,453,215
Nebraska	27,481,300	7,694,764	28	10,992,520	16,488,780
California	36,322,000	8,717,280	24	9,443,720	26,878,280
Oregon	13,122,400	2,220,808	17	3,936,720	9,185,680
Nevada	99,200	26,784	27	77,376	21,824
Colorado	2,394,000	790,020	33	909,720	1,484,280
Arizona	......	......	......	......	......
Dakota	16,128,000	3,386,880	21	3,709,440	12,[illegible]500
Idaho	......	......	......	......	......
Montana	942,000	254,340	27	423,900	51[illegible]
New Mexico	977,900	244,475	25	811,657	[illegible]
Utah	1,579,400	473,820	30	931,846	[illegible]554
Washington	3,182,700	732,021	23	2,068,755	1,[illegible],945
Wyoming	......	......	......	......	......
Indian Territory	......	......	......	......	......
Total	420,154,500	119,273,012	28.4	175,650,785	244,503,715

"Consumed in the county" includes all flour made in the county where the wheat is grown, whether for home use or shipment elsewhere.

PROPORTION OF GRADES.

An examination of the inspection records of wheat in the principal cities shows that very little grades as No. 1, so that practically No. 2 is the highest grade. As is well known, No. 2 is the standard grade for quotations of prices of wheat.

A compilation of the statistics of the Chicago inspection, as given below, shows that in five years but 3.9 per cent. of the winter and 3.1 of spring was classed as No. 1, while 64 per cent. of winter and 52.6 of spring was graded No. 2. There was 8.4 per cent. of winter below No. 3 and 12.6 per cent. of spring.

The record shows also that three-fourths of the receipts at Chicago are of spring wheat. The proportion of all the lower grades is much greater in spring than in winter wheat, a result of the primitive and negligent style of cultivation in vogue in the districts where all-wheat farming is practiced.

Only 55.7 per cent. of the spring wheat of Chicago, between 1878 and 1882, passed as No. 1 and No. 2, while 67.9 per cent. of the winter wheat was classed in those grades, a difference of more than one-fifth in favor of winter wheat.

The following is a record of receipts, by car loads, for five years:

Grades.	1878.		1879.		1880.		1881.		1882.		Average for five years.	
	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.
Winter:												
No. 1	888	67	597	4.8	198	1.4	4	0.2	901	3.6	536	3.9
No. 2	10,342	78	7,703	61.9	8,567	60.1	651	31.0	17,031	62.6	8,859	64.0
No. 3	1,594	12	3,302	26.6	4,297	30.2	874	41.6	6,337	23.3	3,281	23.7
Below 3	432	3.3	830	6.7	1,181	8.3	570	27.2	2,855	10.5	1,173	8.4
Spring:												
No. 1	6,347	11.9	62	0.1	82	0.2	25	0.1	264	1.2	1,356	3.1
No. 2	24,648	46.2	34,073	48.9	26,660	66.5	17,892	57.3	10,319	48.2	22,718	52.6
No. 3	15,155	28.4	26,945	38.7	9,432	23.5	8,802	28.2	7,950	37.1	13,657	31.7
Below 3	7,187	13.5	8,604	12.3	3,920	9.8	4,503	14.4	2,886	13.5	5,420	12.6
Total cars.	66,593	......	82,116	......	54,337	......	33,321	......	48,633	......	57,000	......
Winter	13,256	19.9	12,432	15.1	14,243	26.2	2,099	6.3	27,214	56.0	13,849	24.3
Spring	53,337	80.1	69,684	84.9	40,094	73.8	31,222	93.7	21,419	44.0	43,151	75.7

The Saint Louis inspection, for four years, makes the quality of the last year's receipts about the same as in 1880 and 1881, but much lower than in 1882. The following table gives the record:

Inspection by grades of wheat in Saint Louis.

Grades.	1880.		1881.		1882.		Ten months of 1883.	
	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.	Cars.	Per cent.
Red winter:								
No. 2	16,068	52.6	10,820	59.3	20,440	73.5	8,964	53.6
No. 3	9,484	31.0	4,276	23.5	4,533	16.3	4,364	26.1
No. 4 winter	3,640	11.9	2,100	11.5	1,423	5.1	1,534	9.2
Below 4	1,370	4.5	1,043	5.7	1,401	5.1	1,867	11.1
Total	30,562	......	18,239	......	27,797	......	16,729	......
Red winter	25,552	83.4	15,096	82.8	24,973	89.8	13,328	79.7
Winter	5,010	16.6	3,143	17.2	2,824	10.2	3,401	20.3

The Detroit inspections are thus reported, for the receipts, between July 1 and November 1, 1883:

Grades.	Cars.	Per cent.
No. 1	1,178	27.7
No. 2	2,387	56.3
No. 3	438	10.3
Rejected	159	3.7
Damaged	80	1.9
Mixed	4	.1
Total	4,246	100.00

This gives 84 per cent. Nos. 1 and 2, a better showing than the Chicago average of four years. Mr. L. M. Miller sends the estimates of the Detroit Board of Trade as to average weight of wheat, as follows: From 1874 to 1876, 59 to 59½ pounds; 1877 to 1880, full 60 pounds; 1881, 59½ to 59¾; 1882, 57½ to 58 pounds; 1883, 58½ pounds.

Mr. J. D. Hayes contributes the following relative to Michigan wheat:

In reply to your favor, I would say the average run of white wheat, when sound, is 60 pounds per bushel. For the past three years there has been a very wide difference in weight as well as quality of wheat, owing to its being out of condition; 1882 crop in Michigan was very large and in good condition up to harvesting, when the continuous rains ruined about 11,000,000 bushels in this State, and a very large amount of what was marketed was unsound, grown, and light weight. The same thing occurred again this year on white wheat, while the small, very red wheat, ungrown when harvested, will weigh from 60 to 63 pounds per standard measured bushel.

Mr. A. D. Sterling, inspector of the New York Produce Exchange, sends the following statement of inspections up to March, which shows but 35 per cent. of No. 2 wheat.

Grades.	Cars.	Grades.	Cars.
State white wheat	8	No. 3 N. W. spring	2
No. 1 white wheat	48	No. 2 spring	8
No. 2 white wheat	34	No. 3 spring	17
No. 3 white wheat	5	Rejected	58
No. 1 red wheat	264	No estb. grade	1,333
No. 2 red wheat	3,204	Str. 2 white wheat	3
No. 3 red wheat	3,638	Str. 2 red wheat	184
No. 4 red wheat	601	Str. 3 red wheat	151
Mixed wheat	13	Str. mixed	1
Unmerchantable wheat	10		
No. 1 N. W. spring	1	Total	9,816
No. 2 N. W. spring	238		

Mr. William Wheatley, secretary of the Baltimore Corn and Flour Exchange, reports that choice Fultz and long berry of Western Mar will weigh 62 pounds for the former and 61 pounds for the latter; the Southern Maryland wheat will weigh 59 pounds.

The Maryland Grange Agency reports the weight of wheat of the northern and western counties: No. 1, 62 to 64 pounds; No. 2 red winter, 60 pounds; steamer red winter, 59 pounds. Between the Potomac and Chesapeake; No. 1, 60: No. 2 red winter, 58; steamer red winter, 56 to 57. For the Eastern Shore: No. 1, 60 to 62; No. 2 red winter, 59 to 60; steamer red winter, 58 to 59 pounds. This would make average about 60 pounds for the State crop.

A Maryland miller, J. Olney Norris, makes the average weight of Maryland wheat about 58 pounds for a series of years. The western counties' wheat is heavier than that of other districts.

WEIGHT OF WHEAT.

In order to ascertain the relative value of the wheat harvested in 1883, as compared with the average for a series of years, the Department sent inquiries to the leading millers, grain dealers and boards of trade in all parts of the country, as well as to its State agents, asking the average weight per measured bushel for a number of years, and the average weight of the crop of 1883. The correspondents were instructed, in making their estimates, to take into consideration the poor grades, as well as the more marketable ones, and give an average for all.

Returns were made, not only from the great wheat-growing districts, but from all parts of the country. They were carefully compiled, but there is room only for a few points in the investigation.

The State agent of Connecticut, T. S. Gold, estimates the weight of No. 1 at 60 pounds and No. 2 at 59, and claims that nearly half is of the first grade. The New York agent, F. D. Curtis, admits light average weight, placing the average at 57 pounds. The Millers' Association of Pennsylvania, by its secretary, Landis Levan, makes the average 60 pounds.

In Virginia, the State agent, Mr. Blanton, thinks the average weight of the crop of 1883 was 60 pounds, and that the average for a series of years would be less. A. M. Call, a miller of Henrico County, estimates the wheat of that region at 58 pounds, or 59 when well cleaned, but that wheat of well-cultivated fields usually makes a weight of 62 to 63 pounds per bushel, with yields of 15 to 20 bushels per acre.

W. B. Baker & Co., of Winchester, estimate for the Shenandoah Valley 62 pounds for 1883, 60 for 1882, and 61 as a general average.

Andrew Bowling, a miller of Augusta County, Virginia, says the crop of 1883, in his vicinity, is exceptionally good, and thinks it will weigh 63 pounds.

A. A. McAllister, a miller of Covington, estimates the crop of 1883 at 62½ pounds, and for five years past 61 pounds.

The State agent of Georgia, R. J. Redding, makes the State average for ten years between 54 and 55 pounds, and for 1883 between 56 and 57 pounds.

The president of a Houston (Texas) milling company, D. P. Shephard, estimates the average weight of the crop of that State at 59 pounds for each of five years, including 1883; 58 for four years, and 56 for 1874.

The average would be a little lower than that for 1883. He reports as follows:

Texas wheat is, as a rule, quite heavy. The grain is small, plump, and firm, and frequently weighs 63 pounds—the highest in my experience as a miller, nine years, being 64 pounds. Much allowance should be made for loose and careless cultivation and lack of proper care after cutting; also for want of proper cleaning when it comes to the market, which reduces the weight. Wheat-growing in our State is in its infancy, and its development will be slow, owing to native predilections in favor of cotton, which can be grown profitably over the entire area of the State. Yet the capabilities of Texas, especially the northern half of her territory, are vast, and the quality of the grain superb. The Mediterranean variety seems to be developing into a variety peculiarly suited to this soil and climate, and quite superior to the original type.

State Agent C. E. Bowman, of Kentucky, estimates the crop of 1883 at 58 pounds; that of 1881 at 60, those of 1880 and 1882 at 64 to 65 pounds—the best on record.

W. C. Smith, of Louisville, makes the weight of the last crop 57 pounds; George Denny & Co., of Lancaster, report for that section 59 to 60 pounds in 1883.

Secretary W. J. Chamberlain, of Ohio, places the average for a series of years at 60 to 61 pounds, and that of the last crop at 55.

The Akron miller, Ferdinand Shoemaker, makes slightly lower estimates—59 pounds as the usual average and 56 for the last crop.

The Toledo inspections, from July 10 to November 1, amounted to 12,903 car loads, of which 50 per cent. or 6,540 early No. 2, 3,617 No. 3, with three times as much of No. 4 as of No. 1.

The Michigan department of agriculture, as the result of an investigation, fix the average at 56.4 pounds per bushel.

Our State agent of Minnesota makes the following statement in his report:

Since my letter of November 20 was written I have succeeded, with the assistance of one of our oldest and most intelligent wheat dealers, in finding data for the information you requested about the average weights of Minnesota wheat crops. First, he informed me that my method of ascertaining the weight of the crop of 1882 was wrong, because I made up my average from the minimum weight of each grade, whereas the average for each grade approaches much more nearly the maximum weight. He claims that the average for the crop of 1882 was 58.52 pounds per bushel, instead of 57.32, as I made it. This year's crop, according to his estimate, will average fully 59.21 pounds per bushel. His estimates of former crops are as follows:

	Pounds per bushel.
Crop of 1872, average	57.94
1873, average	58.78
1874, average	57.89
1875, average	58.64
1876, average	54.27
1877, average	59.62
1878, average	56.81
1879, average	55.72
1880, average	58.14
1881, average	57.76
1882, average	58.52
1883, average	59.21

I am satisfied that these estimates approximate the truth very closely, as they are made up from records of transactions in wheat in all parts of the State.

Charles A. Pillsbury, of Pillsbury Mills, Minneapolis, Minn., thinks 56 pounds per bushel would be an average weight. He says, "A certain per cent. of it is frost-bitten and somewhat pinched, and the wheat in such localties is lighter on this account."

J. A. Christian & Co., millers, of Minneapolis, estimate the average of 1883 at 57½ to 58 pounds.

W. P. Brown, of the Mazeppa Mill Company, at Red Wing, Minn., says the wheat of that vicinity averages 58½ pounds, and that in 1879 it was but 51, while in 1878 it was 59 pounds. The crop of 1883 is the best in that region.

The secretary of the Millers' National Association, S. H. Seamans, of Milwaukee, says the Wisconsin crop is better than for six years past, and he averages the last crop at 57 to 57½ pounds.

Mr. J. J. Snouffer, of the Millers' Association, at Cedar Rapids, Iowa, reports a reduction of weight as compared with an earlier period. He makes the average 59 pounds from 1863 to 1873, and 56 from 1873 to 1883, but places the crop of 1883 at 58 pounds.

The Kansas State agent, J. M. McFarland, reports the following:

My sources of information are flouring mills and elevators in various sections of the State, opinions of individuals, and a statement from the secretary of the Kansas City Board of Trade. The figures of 1883 are based principally upon receipts at Kansas City from July 1 to November 10.

Years.	Weight per bushel.	Years.	Weight per bushel.
	Pounds.		*Pounds.*
1876	54.10	1880	55.65
1877	53.63	1881	53.40
1878	55.90	1882	57.29
1879	54.64	1883	53.00

The secretary of the Kansas Mill Owners and Manufacturers' Fire Insurance Company, Robert Atkinson, makes an estimate of 57 pounds per bushel.

The returns of correspondents have been full, corresponding well with returns of commercial and milling organizations generally. In some States there is a little discrepancy, which has been harmonized in the interest of accuracy, and with a desire to get as near to the actual truth as possible. The following result is obtained from the application of these average weights to the number of measured bushels, as reported:

States and Territories.	Weight per bushel.	Bushels of crop.	Weight.	Bushels of 60 pounds.
			Pounds.	
Maine	56	614,300	34,400,800	573,347
New Hampshire	57	181,700	10,356,900	172,615
Vermont	57	353,700	20,160,900	336,015
Massachusetts	58	19,700	1,142,600	19,043
Connecticut	58	34,300	1,989,400	33,157
New York	57	8,035,200	458,006,400	7,633,440
New Jersey	59	2,063,600	121,752,400	2,029,207
Pennsylvania	59	20,043,800	1,182,584,200	19,709,737
Delaware	59	966,700	57,035,300	950,588
Maryland	59	7,577,000	447,043,000	7,450,717
Virginia	59	8,352,800	492,815,200	8,213,587
North Carolina	58.5	4,230,800	247,501,800	4,125,030
South Carolina	58	1,136,200	65,899,600	1,098,327
Georgia	57	2,574,900	146,769,300	2,446,155
Alabama	56.5	1,437,500	81,218,750	1,353,646
Mississippi	56	247,500	13,860,000	231,000
Texas	58	4,301,000	249,458,000	4,157,633
Arkansas	57	1,416,400	80,734,800	1,345,580
Tennessee	57	7,408,800	422,301,600	7,038,360

States and Territories.	Weight per bushel.	Bushels of crop.	Weight.	Bushels of 60 pounds.
			Pounds.	
West Virginia	57	4,257,000	242,649,000	4,044,150
Kentucky	59	9,612,600	567,143,400	9,452,390
Ohio	55	25,884,000	1,423,620,000	23,727,000
Michigan	56	25,011,000	1,400,616,000	23,343,600
Indiana	56	28,447,800	1,593,076,800	26,551,280
Illinois	56	22,150,000	1,240,400,000	20,673,333
Wisconsin	56	19,604,900	1,097,874,400	18,297,907
Minnesota	57	33,773,200	1,925,072,400	32,084,540
Iowa	56	27,518,800	1,541,052,800	25,684,213
Missouri	58	23,819,300	1,381,519,400	23,025,323
Kansas	54	26,851,100	1,449,959,400	24,165,990
Nebraska	57	27,481,300	1,566,434,100	26,107,235
California	58	36,322,000	2,106,676,000	35,111,267
Oregon	59	13,122,400	774,221,600	12,903,693
Nevada	58	99,200	5,753,600	95,893
Colorado	59	2,394,000	141,246,000	2,354,100
Dakota	57	16,128,000	919,296,000	15,321,600
Montana	59	942,000	55,578,000	920,300
New Mexico	56	977,900	54,762,400	912,707
Utah	59	1,579,400	93,184,600	1,553,077
Washington	60	3,182,700	190,962,000	3,182,700
Total	....	420,154,500	23,906,128,850	398,435,481

This makes a loss in weight of about twenty million bushels, upon the basis of 60 pounds per bushel; but it is evident, from the whole tenor of these returns and current records of wheat inspection, that the average rate of our wheat for a series of years is not 60 pounds, and is probably not more than 59 pounds. Nor does this average fall below that of most other countries. There is always a considerable proportion of low-grade wheat, and a wide range is observed in the weight of different varieties and local growths, from 54 to 64 pounds, and in extreme cases still greater differences.

AGRICULTURAL GRAPHICS.

A REPORT UPON EXHIBITS OF THE BUREAU OF STATISTICS OF THE DEPARTMENT OF AGRICULTURE, BEING DIAGRAMS ILLUSTRATING THE AGRICULTURAL STATISTICS OF THE UNITED STATES, PREPARED UNDER DIRECTION OF THE STATISTICIAN OF THE DEPARTMENT.*

SIR: The development of statistical organization in this country during the past generation has been one of the marked features of educational progress. Every department of the National Government has its machinery for statistical investigation. The States have their organization for collating or collecting fiscal or agricultural statistics. Commercial boards and agricultural societies participate in the work of co-ordination of important data. A spirit of statistical inquiry is abroad, accompanying the schoolmaster, invading the press, and sometimes the pulpit.

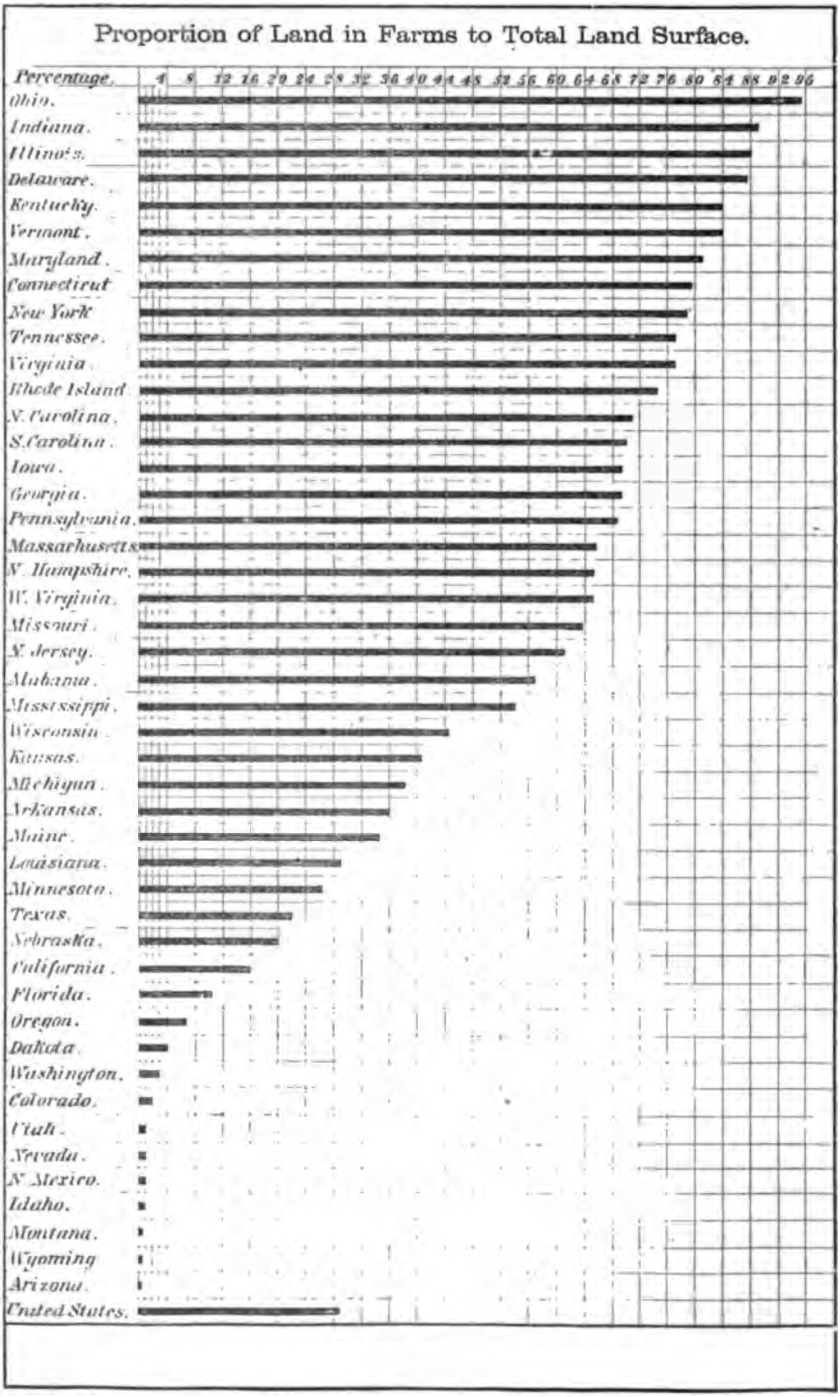
What is better, and manifestly the explanation of the increased popular appreciation of the uses of statistics, the multitude no longer look with suspicion and distrust upon the collection of statistics, rendering more efficient effort possible, and paving the way for better co-operation in the work. Fifty years ago the ignorance and suspicion of the people made impossible what is now easy of acquisition. It is not long since I had occasion thus to note the lingering of such prejudices in these words:

It is well known to statisticians that in the past the greatest bar to efficiency in census work was found in the ignorance, the indifference, or the actual opposition of individuals from whom primary data must be obtained. Man, in the individuality and selfishness of his wild or savage state, has not learned to yield gracefully something of his natural rights to the general welfare of the community, and his partly-civilized brother is much inclined to resent as an impertinence the well-meaning and even beneficent attempts of the statistical inquirer. He is suspicious, and fears a tax levy if the inquirer is a Government official, and some economic disadvantage if he is a fellow-craftsman. It is wonderful to observe the lingering of some such prejudice in the minds of multitudes of no little intelligence and a degree of culture. It is gratifying to see these mists of ignorance and prejudice disappearing in the brightening light of the practical culture of the present day.

The necessity of impartial crop statistics, for the protection of farmers against attempts of speculators to depress prices temporarily for personal gain, is more and more apparent. With increase of interest in statistics there arises a persistent disposition in adventurers and sharpers to utilize it for their selfish and fraudulent purposes. "Statisticians spring up like mushrooms in every avenue of publicity, and by appropriation of results of organized work and the unfounded assumption of original effort make an exhibit that is fraudulent in its method rather than inaccurate in its estimates. Others, equally unscrupulous, with an eye to gain, distort facts to affect the markets, to elevate and depress prices, from gambling considerations. This cannot be prevented; the gambling spirit pervades the trading marts of the country; but the great body of consumers and honest middlemen should question sharply the efforts of all interested parties who aim to mold public opinion through printed circulars and the public press. They should learn to

* Made to Mr. William Saunders, representative of the Department of Agriculture at the New Orleans Exposition.

DIAGRAM I.


Proportion of Land in Farms to Total Land Surface.
Percentage.
4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80 84 88 92 96
Ohio.
Indiana.
Illinois.
Delaware.
Kentucky.
Vermont.
Maryland.
Connecticut
New York
Tennessee.
Virginia.
Rhode Island
N. Carolina.
S. Carolina.
Iowa.
Georgia.
Pennsylvania.
Massachusetts
N. Hampshire.
W. Virginia.
Missouri.
N. Jersey.
Alabama.
Mississippi.
Wisconsin.
Kansas.
Michigan.
Arkansas.
Maine.
Louisiana.
Minnesota.
Texas.
Nebraska.
California.
Florida.
Oregon.
Dakota.
Washington.
Colorado.
Utah.
Nevada.
N. Mexico.
Idaho.
Montana.
Wyoming
Arizona.
United States.

discriminate between the true and the false, and to discount the statements that are manufactured to affect the market. These remarks apply only to statistics deliberately made for the purposes of dishonest in. To assume that such practices are unknown would be the height confiding simplicity. Nor is it strange that in the eager hunt for vs reputable public news-gatherers should inadvertently accept the statements of interested persons concerning crop production.

"It is the province of official statistics to protect the producer and consumer, by an accurate forecast of crop production, against the speculor, who would confiscate the profits of the farmer and reduce the bread supply of the poor without giving the pretense of an equivalent. y millions of dollars have been already saved from this piracy by ial crop reports."

The best interpreter of statistics, to the popular mind, is the graphic thod of illustration. It has been said to be impossible for the human nd to measure accurately and instantly the purport and true extent a billion. To the ordinary mind the real meaning of figures is dimly ceived. Their examination, therefore, becomes intolerably "dry." requires a statistical education to prepare one for utilizing fully ical statements. If the eye, and through it all the perceptive ties, can aid in measurements and comparisons the thorough unnding of the occult and mysterious figures arrayed in solid and netrable phalanx, the help to the novice is invaluable. To make meaning of important facts in American agriculture so plain that who runs through the New Orleans Exposition can read intelligently he runs, has been the object in the preparation of the diagrams presnted for exhibition by the Bureau of Statistics of the Department of griculture.

PROPORTION OF LAND IN FARMS.

Diagram I has no reference to relative areas in farms in the several States and Territories, but simply to the *proportion* of the superficial area of each which is occupied by farms. The horizontal lines represent percentage of the entire area, which the perpendicular lines mark, from left to right, by numbers, one, two, three, to twenty-nine.

It will be seen that the State most fully occupied is Ohio, which has only six per cent. of its land surface in town area, roads, or waste lands. The Ohio Valley stands above the older settlements, Pennsylvania, New York, or Massachusetts, in the proportion of surface in farms, Indiana having 88.9 per cent.; Illinois, 88.4. Kentucky, with 84 per cent., ails of the next place, which is taken by the little, but well occupied, State of Delaware, with 86.9 per cent. The next in order are Vermont, 3.5; Maryland, 81.1; Connecticut, 79.1; New York, 78.

The divisions having less than 28.9 per cent., the average for the United States, are Louisiana, Minnesota, Texas, Nebraska, California, Florida, Oregon, Colorado, Nevada, and all the Territories. Iowa, a new State, had already (in 1880) seven-tenths of her superficial area occupied as farms.

The mountain area of New England and the Alleghanian system, much of which is unsuitable for farming operations, depress the percentage in these old States. The average in the six Eastern States is 4.1 per cent.; in four Middle States, 72.9; in the Southern, from Maryland to Kentucky, 43.3; in the Western, to the Rocky Mountains, including Missouri and Kansas on the south, 54.4; in the Pacific and

Rocky Mountain States, 7.6; in the Territories, 1.4. A large part of the elevated western areas is assumed to be unfit for general agriculture, though special culture, carefully adapted to situation and humidity, with ameliorations of irrigation and cultivation and judicious selection of plants in crop distribution, will produce results in agriculture which will surprise the farmers of to-day who live to witness the developments of twenty years.

The following is the statement on which the diagram is based:

Proportion of land in farms to total land surface.

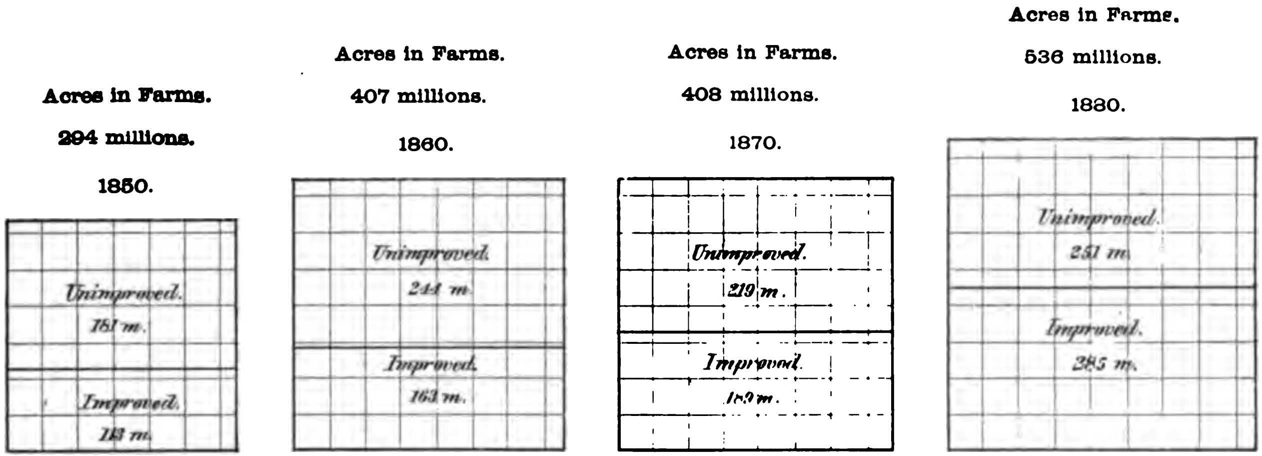
States and Territories.	Proportion.	States and Territories.	Proportion.	States and Territories.	Proportion.
Maine	34.2	Alabama	57.2	Missouri	63.4
New Hampshire	64.6	Mississippi	53.5	Kansas	41.0
Vermont	83.5	Louisiana	28.5	Nebraska	20.4
Massachusetts	65.3	Texas	21.6	California	16.6
Rhode Island	74.1	Arkansas	35.5	Oregon	7.0
Connecticut	79.1	Tennessee	77.3	Nevada	.8
New York	78.0	West Virginia	64.6	Colorado	1.8
New Jersey	61.4	Kentucky	84.0	Arizona	.2
Pennsylvania	68.7	Ohio	94.0	Dakota	4.0
Delaware	86.9	Michigan	37.6	Idaho	.6
Maryland	81.1	Indiana	88.9	Montana	.4
Virginia	77.2	Illinois	88.4	New Mexico	.8
North Carolina	71.9	Wisconsin	44.1	Utah	1.2
South Carolina	69.7	Minnesota	26.4	Washington	3.3
Georgia	69.0	Iowa	69.7	Wyoming	.2
Florida	9.5				

The actual land areas reported, by the census of 1880, of States and farm lands in each, from which the foregoing proportions are obtained, are as follows:

States and Territories.	Land in farms.	Total land surface.	States and Territories.	Land in farms.	Total land surface.
Maine	6,552,578	19,132,800	Kentucky	21,495,240	25,600,000
New Hampshire	3,721,173	5,763,200	Ohio	24,529,226	26,086,400
Vermont	4,882,588	5,846,400	Michigan	13,807,240	36,755,200
Massachusetts	3,359,079	5,145,600	Indiana	20,420,983	22,982,400
Rhode Island	514,813	694,400	Illinois	31,673,645	35,840,000
Connecticut	2,453,541	3,100,800	Wisconsin	15,353,118	34,848,000
New York	23,780,754	30,476,800	Minnesota	13,403,019	50,691,200
New Jersey	2,929,773	4,771,200	Iowa	24,752,700	35,504,000
Pennsylvania	19,791,341	28,790,400	Missouri	27,879,276	43,990,400
Delaware	1,090,245	1,254,400	Kansas	21,417,468	52,228,600
Maryland	5,119,831	6,310,400	Nebraska	9,944,826	48,758,400
Virginia	19,835,785	25,680,000	California	16,593,742	99,827,200
North Carolina	22,363,558	31,091,200	Oregon	4,214,712	60,518,400
South Carolina	13,457,613	19,308,800	Nevada	530,862	70,233,600
Georgia	26,043,282	37,747,200	Colorado	1,165,373	66,332,800
Florida	3,297,324	34,713,600	Arizona	135,573	72,268,800
Alabama	18,855,334	32,985,600	Dakota	3,800,656	94,528,000
Mississippi	15,855,462	29,657,600	Idaho	327,798	53,945,600
Louisiana	8,273,506	29,068,800	Montana	405,683	92,998,400
Texas	36,292,219	167,865,600	New Mexico	631,131	78,374,400
Arkansas	12,061,547	33,948,800	Utah	655,524	52,601,600
Tennessee	20,666,915	26,720,000	Washington	1,409,421	42,803,200
West Virginia	10,193,779	15,772,800	Wyoming	124,433	62,448,000

The land surface of the United States makes an aggregate of 1,856,108,800 acres, of which 536,081,835 are comprised in farms. This is exclusive of the Indian Territory and Alaska.

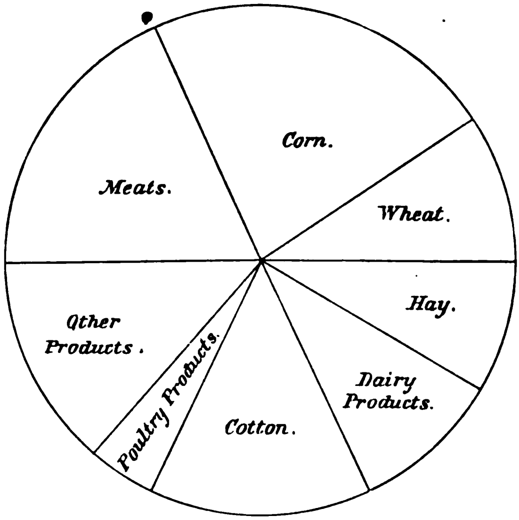
Increase of Farm Area in Thirty Years.



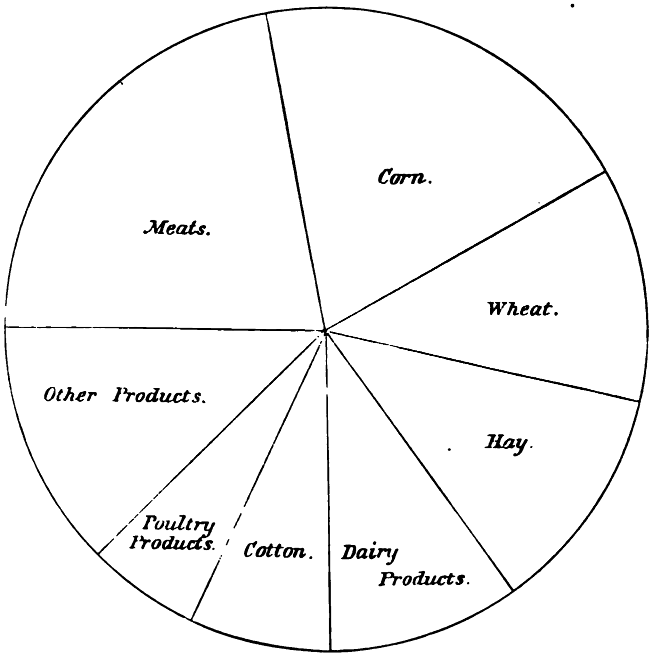
Scale, 7 millions acres per square.

Increase of Farm Values of Agricultural Products in Twenty Years.

1859.



1879.



INCREASE OF FARM ACREAGE IN THIRTY YEARS.

The farm area of the United States has nearly doubled in thirty years, increasing from 293,560,614 to 536,081,835 acres. During the first ten years the taking up of Government lands in the West and South and the State lands of Texas was active. The most fertile areas, little encroached upon in the newer settlements, were taken possession of with a certainty of appreciation in value that added intensity to the pursuit of homes obtainable at insignificant prices. The absolutely free homestead had not at that time been guaranteed by law. In the next decade the disturbing element of civil war prevented aggregate increase, the States within the theater of actual warfare declining in area, some farms being abandoned and hence not counted as farms. At the same time many of the Western States showed a considerable increase. Kansas, for instance, with 1,778,400 acres in 1860, had 5,656,879 in 1870.

Between 1870 and 1880 the new lands taken into the farm area exceeded 128,000,000 acres. Of this no less than 49,000,000 were in six divisions between the Mississippi and the Rocky Mountains. The increase was large in the South, especially in Texas, where it was nearly 18,000,000.

The proportion of unimproved land, notwithstanding the new land taken up, has been constantly decreasing. It was 61.5 per cent. in 1850; 59.9 in 1860; 53.7 in 1870; and 46.2 in 1880. The aggregates are:

Years.	Farm land.	Improved land.
1850	293, 560, 614	113, 032, 614
1860	407, 212, 538	163, 110, 720
1870	407, 735, 041	188, 921, 099
1880	536, 081, 835	284, 771, 042

Diagram II shows these areas in squares drawn to a scale of 1,000,000 acres per square inch, the improved and unimproved distinguished by different colors.

FARM VALUES OF PRODUCTS OF AGRICULTURE.

The increase of twenty years in the values of products of American agriculture has been far greater than the increase in population. Quantities have enormously increased, and values have changed, some being lower and others higher than in 1860. The principal products are shown in Diagram III in the order of their prominence. Meat, which represents ranch grass or pasturage, is first, followed by corn, wheat, hay, dairy products, cotton, poultry products, &c. Corn stood first in 1860, because the grains of the western half of the continent were unutilized, and meat production east of the Mississippi has assumed greatly enlarged proportions. A part of the corn, about half, and a small part of the hay are duplicated in the values of meats. The dairy products are principally from pasturage, and therefore do not duplicate extensively values of other items. The products represented in the

diagram, and the proportion of each in the two periods are given in millions of dollars, as follows:

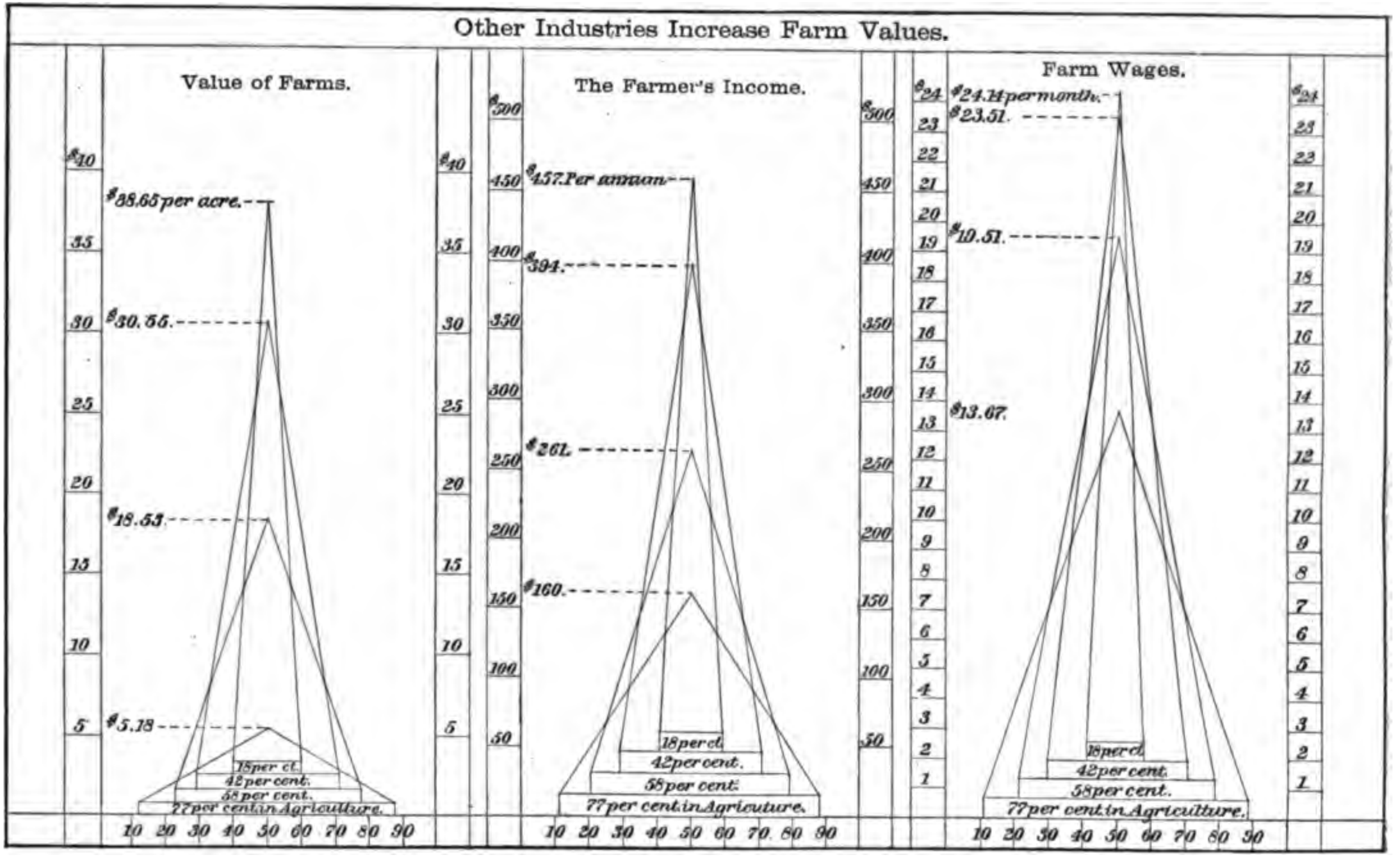
Articles.	1859.		1879.	
	Value of product.	Per cent.	Value of product.	Per cent.
Meats	300	17.9	800	21.5
Corn	361	21.5	695	18.7
Wheat	125	7.5	437	11.7
Hay	153	9.1	410	11.0
Dairy products	152	9.1	358	9.5
Cotton	212	12.6	272	7.3
Poultry products	75	4.5	180	4.8
Other products	298	17.8	579	15.5
Total	1,676	100.0	3,726	100.0

The productions of farms in detail, quantity, and value of the two periods, were substantially as in the following table, not including of corn, straw, milk consumed in farmers' families, field crops of roots, and numerous small products, which may be held to offset the dupli tions of corn in meat-making and the far smaller duplications in dairying, for a vast preponderance in values of meats, butter, and ch derived from grass depastured.

Comparison of quantities and farm values of products of agriculture of the United S produced in 1859 and 1879.

Products.	1859.			1879.		
	Quantity.	Price.	Value.	Quantity.	Price.	Value.
Corn ....bushels..	838, 792, 740	$0 43	$360, 080, 878	1, 754, 591, 676	$0 39.6	$694, 818, [illegible]
Wheat ....do....	173, 104, 924	72	124, 635, 545	459, 483, 137	95.1	436, 968, 463
Oats ....do....	172, 643, 185	25	43, 160, 796	407, 858, 999	36	146, 82[illegible]
Rye..........do....	21, 101, 380	52	10, 972, 718	19, 831, 5[illegible]5	75.6	14, [illegible]
Barley ....do....	15, 825, 898	55	8, 704, 244	43, 907, 405	66.6	29, [illegible]
Buckwheat...... do....	17, 571, 818	58	10, 191, 654	11, 817, 327	59.4	7, [illegible]
Rice..........pounds..	187, 167, 032	3.5	6, 550, 846	110, 131, 373	6	6, [illegible]
Irish potatoes.bushels..	111, 148, 867	40	44, 459, 547	169, 458, 539	48.3	81, [illegible]
Sweet potatoes...do....	42, 095, 026	40	16, 838, 010	33, 378, 093	45	15, [illegible]
Hay..........tons..	19, 083, 896	8 00	152, 671, 168	35, 150, 711	11 65	409, [illegible]
Cotton ....pounds..	2, 274, 372, 309	9.3	211, 516, 625	2, 771, 797, 156	9.8	271, 634, [illegible]
Tobacco.......... do....	434, 209, 461	5	21, 710, 473	472, 661, 157	8.2	38, 758, [illegible]
Peas and beans.bushels.	15, 061, 905	1 33	20, 032, 453	9, 590, 027	1 50	14, 385, [illegible]
Market garden	....	....	16, 159, 498	....	....	21, 761, 250
Orchard products..........	....	....	19, 991, 885	....	....	50, 876, 154
Hops ....pounds..	10, 991, 996	7	769, 440	26, 546, 378	24	6, 371, 131
Hemp .... tons..	74, 493	190 00	14, 153, 670	5, 025	200 00	1, 005, 000
Flax ....pounds..	4, 720, 145	20	944, 029	1, 565, 546	25	391, 387
Flax-seed .....bushels..	566, 867	1 00	566, 867	7, 170, 951	1 25	8, 963, [illegible]
Cane sugar hogsheads..	230, 982	85 00	19, 633, 470	178, 872	90 00	16, 098, 480
Maple sugar...pounds..	40, 120, 205	12	4, 814, 425	36, 576, 061	13	4, 754, [illegible]
Cane molasses.gallons..	14, 963, 996	30	4, 489, 199	16, 573, 273	35	5, 800, [illegible]
Sorghum sirup ..do....	6, 749, 123	30	2, 024, 737	28, 444, 202	33	9, 386, 587
Maple sirup ......do....	1, 597, 589	80	1, 278, 071	1, 796, 048	1 00	1, 796, 048
Beeswax ......pounds..	1, 322, 787	30	396, 836	1, 105, 689	33	364, 877
Honey.......... do ...	25, 366, 357	20	4, 673, 271	25, 743, 208	22	5, 663, 506
Grass-seed ....bushels..	900, 040	1 40	1, 260, 056	1, 317, 701	1 50	1, 976, 552
Cloverseed ...... do ...	956, 188	5 00	4, 780, 940	1, 922, 982	6 00	11, 537, 892
Wines..........gallons..	1, 627, 242	50	813, 621	20, 000, 000	60	12, 000, 000
Wool .... pounds..	75, 000, 000	26	19, 500, 000	240, 681, 751	28	67, 390, 890
Meats	....	....	300, 000, 000	....	....	800, 000, 000
Butter.........pounds..	500, 000, 000	16	80, 000, 000	900, 000, 000	21	189, 000, 000
Cheese ....do....	130, 000, 000	9.5	12, 350, 000	300, 000, 000	9.5	28, 500, 000
Milk, consumed.gallon..	1, 000, 000, 000	6	60, 000, 000	1, 800, 000, 000	7.5	135, 000, 000
Poultry products	....	....	75, 000, 000	....	....	180, 000, 000
Aggregate values.	....	....	1, 675, 724, 972	....	....	3, 726, 331, 422

DIAGRAM IV.



Other Industries Increase Farm Values.
Value of Farms.
$38.65 per acre.
$30.55.
$18.53.
$5.18
18 per ct.
42 per cent.
58 per cent.
77 per cent in Agriculture.
The Farmer's Income.
$457. Per annum
$394.
$261.
$160.
18 per ct.
42 per cent.
58 per cent.
77 per cent. in Agriculture.
Farm Wages.
$24.14 per month.
$23.51.
$19.51.
$13.67.
18 per ct.
42 per cent.
58 per cent.
77 per cent. in Agriculture.

OTHER INDUSTRIES INCREASE FARM VALUES.

The settler in new communities, the pioneer in cultivation of wild areas, who avails himself of his opportunity to select the choicest lands, naturally and rightfully expects to be benefited in the future by increase of values. He may hope that his children will derive further advantage. His reasonable expectations are sometimes fulfilled; often they are disappointed. If the soil proves to be less fertile than more favored regions, or railway facilities are denied, settlement will be slow, roads poor, schools half supported; with such conditions prices of lands will advance with provoking tardiness. If the soil is rich and settlement rapid, till all the land is occupied, while there are no industries beyond the line of agriculture, no families dependent on their neighbors for food supplies, no mines or mills, a certain level of moderate values may be reached, but no high prices of land or products will result. This is proved by the census and other reliable facts on which the figures of Diagram IV are based, and by similar facts in the history of every country in which varied industries flourish. The statement that "other industries increase farm values" is, therefore, axiomatic rather than theoretical. The same facts, and similar data in all industrial history, show that mere increase of population does not produce the highest values. Industry, not population, creates wealth. Prices are not enhanced by the presence of paupers. Increase of farmers advances prices in new settlements; beyond a certain limit numbers may diminish prices, as in parts of India and other countries. Dense population, all employed in agriculture, can never raise prices or produce prosperity as the same population judiciously proportioned among productive industries. The increment will ever be "proportionate, not to numbers, but to productive forces in action, degree in skill, persistence in labor."

The diagram establishes this hypothesis: "*Values in agriculture are enhanced by increase of non-agricultural population.*"

It includes three similar figures, each outlining a pyramid, the base of which represents the sum of human labor in the United States, in the aggregate numbers reported by the census as employed in all occupations. Each pyramid in its structure includes four, the base of each being the percentage proportion of those engaged in agriculture to the aggregate in all occupations.

The broadest base includes all the farm lands in those States in which 70 per cent. or more are employed in agriculture; the next, all farm lands in States where 50 to 70 per cent. are so employed. The other two refer to lands of States where less than half of the labor is agricultural, 30 per cent. being the dividing line between them. The elevation represents comparative value of farm lands from one dollar upwards. All the farm lands in each of these four classes are aggregated, and an exact average of all obtained. The apex of each part of this composite pyramid indicates the average value of each class of lands. The result is striking—$5.18 per acre for States averaging 77 per cent. in agriculture, $13.53 where 58 per cent. are in agriculture, $30.55 for 42 per cent., and $38.65 for 18 per cent. employed in agriculture.

The actual area and value are thus shown in these four classes of States:

Value by classes.

Classes.	Number of States and Territories.	Acres.	Value.	Value per acre.	Workers in agriculture.
					Per cent.
First class	15	77, 250, 742	$2, 985, 641, 197	$38 65	18
Second class	13	112, 821, 257	3, 430, 915, 767	30 55	42
Third class	13	237, 873, 040	3, 212, 108, 070	13 53	58
Fourth class	6	108, 636, 796	562, 430, 842	5 18	77

The first class has 82 per cent. of all labor in industries producing nothing from the soil, and dependent on 18 per cent. employed in food production, or else upon products of other States. These are the more advanced manufacturing States, and mining States and Territories, as follows:

Values in class first.

States and Territories.	Farms.			Workers in agriculture.
	Acres.	Value.	Value per acre.	
				Per cent.
District of Columbia	18, 146	$3, 632, 403	$200 18	2
Massachusetts	3, 359, 079	146, 197, 415	43 52	9
Rhode Island	514, 813	25, 882, 079	50 27	9
Colorado	1, 165, 373	25, 100, 223	21 55	13
Nevada	530, 862	5, 408, 325	10 19	13
Arizona	135, 573	1, 127, 940	8 32	15
New Jersey	2, 929, 773	190, 895, 833	65 16	15
Wyoming	124, 433	835, 805	6 72	18
Connecticut	2, 453, 541	121, 063, 910	49 34	18
Montana	405, 683	3, 234, 504	7 97	20
New York	23, 780, 754	1, 056, 176, 741	44 41	20
Pennsylvania	19, 791, 341	975, 689, 410	49 30	21
California	16, 593, 742	262, 051, 282	15 79	21
Idaho	327, 798	2, 832, 890	8 64	25
Maryland	5, 119, 831	165, 503, 341	32 33	28
Total	77, 250, 742	2, 985, 641, 197	38 65	18

In the District of Columbia the farm lands are so near to a city of nearly 200,000 people that its farm lands are also suburban property, with prices beyond the mere agricultural value. The lands next in value are those of New Jersey, so near to four millions of urban population just across its borders as to make practically a lower proportion in agriculture than Massachusetts or Rhode Island.

Values in class second.

[This list includes the smaller manufacturing States and those of the West where less than half the labor is in agriculture.]

States and Territories.	Farms. Acres.	Farms. Value.	Farms. Value per acre.	Workers in agriculture.
				Per cent.
New Hampshire	3,721,173	$75,834,389	$20 38	31
Delaware	1,090,245	36,789,672	33 74	32
New Mexico	631,131	5,514,399	8 74	35
Maine	6,552,578	102,357,615	15 62	35
Utah	655,524	14,015,178	21 38	36
Ohio	24,529,226	1,127,497,353	45 97	40
Oregon	4,214,712	56,908,575	13 50	40
Washington	1,409,421	13,844,222	9 82	42
Michigan	13,807,240	499,103,181	36 15	42
Illinois	31,673,645	1,009,594,580	31 87	44
Wisconsin	15,353,118	357,709,507	23 30	47
Vermont	4,882,588	109,346,010	22 40	47
Dakota	3,800,656	22,401,084	5 89	49
Total	112,321,257	3,430,915,765	30 55	42

Values in class third.

States.	Farms. Acres.	Farms. Value.	Farms. Value per acre.	Workers in agriculture.
				Per cent.
Virginia	19,835,785	$216,028,107	$10 89	51
Missouri	27,879,276	375,633,307	13 47	51
Minnesota	13,403,019	193,724,260	14 45	52
Indiana	20,420,983	635,236,111	31 11	52
Louisiana	8,273,506	58,989,117	7 13	57
Iowa	24,752,700	567,430,227	22 92	57
Nebraska	9,944,826	105,932,541	10 65	59
West Virginia	10,193,779	133,147,175	13 06	61
Kentucky	21,495,240	299,298,631	13 92	62
Florida	3,297,324	20,291,835	6 15	64
Kansas	21,417,468	235,178,936	10 98	64
Tennessee	20,666,915	206,749,837	10 00	66
Texas	36,292,219	170,468,886	4 70	69
Total	237,873,040	3,218,108,970	13 52	58

Class third includes all States having one-half and not exceeding seven-tenths employed in agriculture, the newer States of the West, and the older and more diversified of the districts of the South.

Values in class fourth.

States.	Farms. Acres.	Farms. Value.	Farms. Value per acre.	Workers in agriculture.
				Per cent.
Georgia	26,043,282	$111,910,540	$4 30	72
North Carolina	22,363,558	135,793,602	6 07	75
South Carolina	13,457,613	68,677,482	5 10	75
Alabama	18,855,334	78,954,648	4 19	77
Mississippi	15,855,462	92,844,915	5 86	82
Arkansas	12,061,547	74,249,655	6 10	83
Total	108,636,796	562,430,842	5 18	77

Class four comprises the part of the South most absorbed in the cot ton industry, least interested in various productions in agriculture, an least advanced in manufactures or mechanical industries.

These figures teach that mono-industrialism is stagnation and pov erty, and variety in industry the life of business and assurance o prosperity.

THE FARMER'S INCOME.

In this statement of "income," net income or profit is not meant, bu the reported value per head of farm production as given in the census The statement, by classes, is as follows:

Classes.	Farms.			Workers in agri- culture.
	Acres.	Value.	Value per acre.	
				Per cent.
First class	1, 060, 681	$484, 770, 797	$457	1[illegible]
Second class	1, 566, 875	616, 850, 959	394	[illegible]
Third class	3, 017, 971	786, 681, 420	261	5[illegible]
Fourth class	2, 024, 966	324, 237, 751	160	7[illegible]

For further details, by States, and explanation of causes of local variation and modification, reference is made to Report No. 3, new series, of the Bureau of Statistics of the Department of Agriculture.

THE FARM LABORER'S WAGES.

The third figure in the diagram shows that the average wages of th farm laborer are subject to similar influences, though to a less degree, a labor is mobile and land stationary. The average wages per month, b the year, were, in 1882, respectively, $24.14, $23.51, $19.51, and $13.6

The diagram illustrates the operation of a law in industrial econom by which the value of farm lands depends more upon the proper dis tribution of productive labor in industries than upon the fertility o the soil, and that the "farmer's income is highest where farms ar fewest."

AVERAGE WAGES PER MONTH.

Diagram V shows the average rate of wages for farm labor by group of States, at four different periods, viz, in 1869, 1875, 1879, and 188 This exhibits remarkable fluctuations, from the highest rates after th war to those of the era of industrial depression, and return to speci payments, followed by an upward swing of the pendulum. These ave ages were:

Group.	1869.	1875.	1879.	1882
California	$46 38	$44 50	$41 00	$38
Eastern States	32 08	28 96	20 21	26
Middle States	28 02	26 02	19 69	22
Western States	27 01	23 60	20 38	23
Southern States	17 21	16 22	13 31	15

DIAGRAM V.

Average wages per month by groups of States.

		1860		1869		1875		1879		1882	
California	$	35	75	46	38	44	50	41	00	38	25
Eastern States	$	33	30	32	08	28	96	20	21	26	61
Middle States	$	30	07	28	02	26	02	19	69	22	24
Western States	$	28	91	27	01	23	60	20	38	23	63
Southern States	$	16	00	17	21	16	22	13	31	15	30

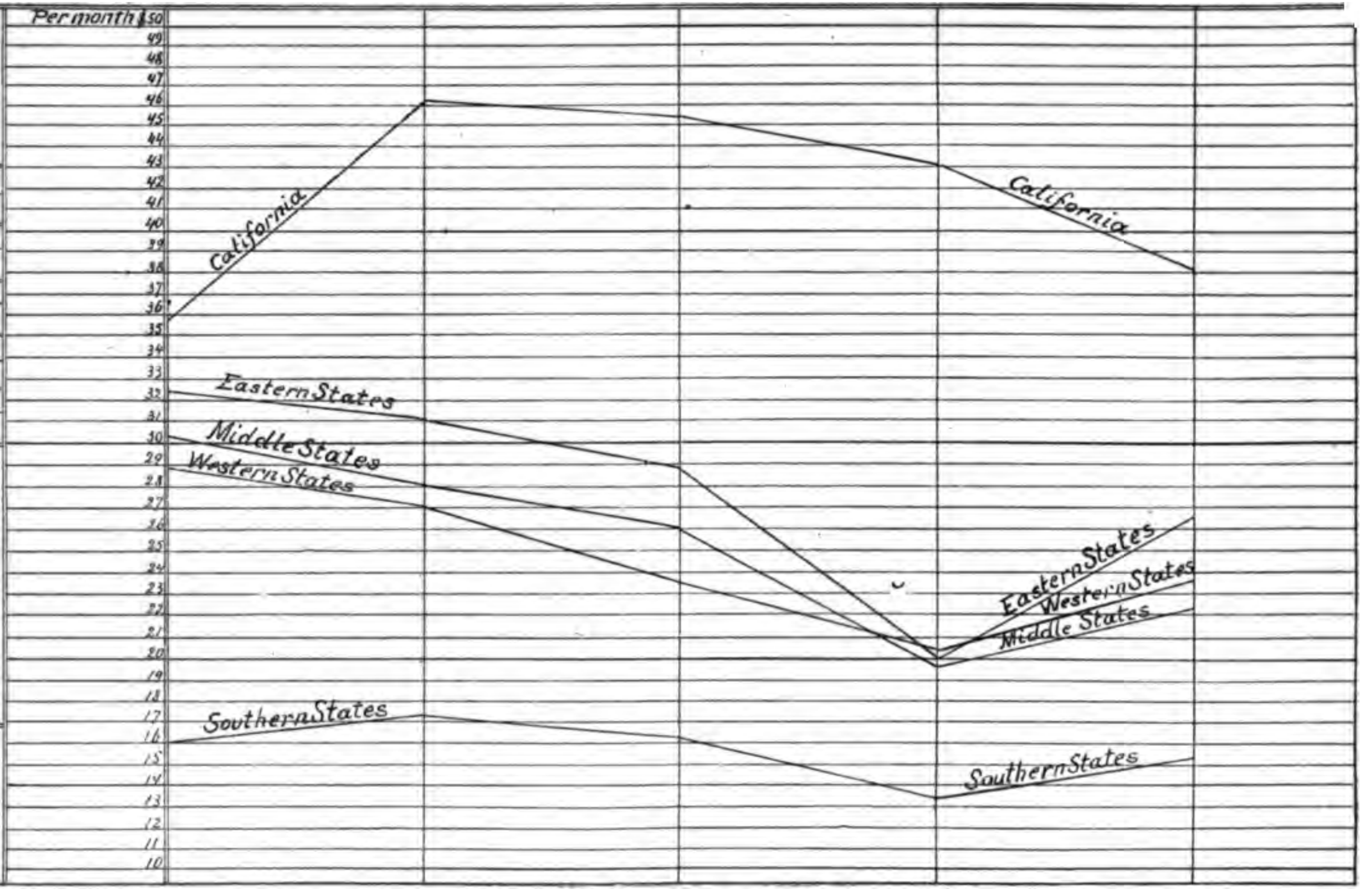


DIAGRAM VI.

Value of Farm Animals in 1884.

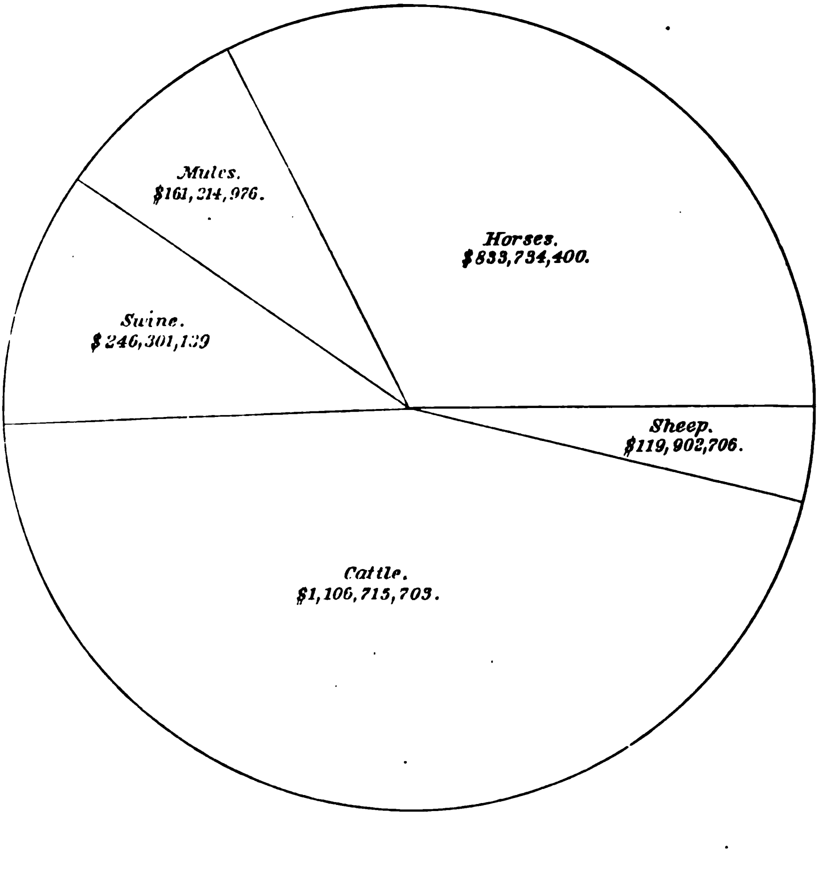


DIAGRAM VII.

Increase of Farm Animals in Thirty Years.

(Exclusive of Ranch Animals. Indicated in millions.)

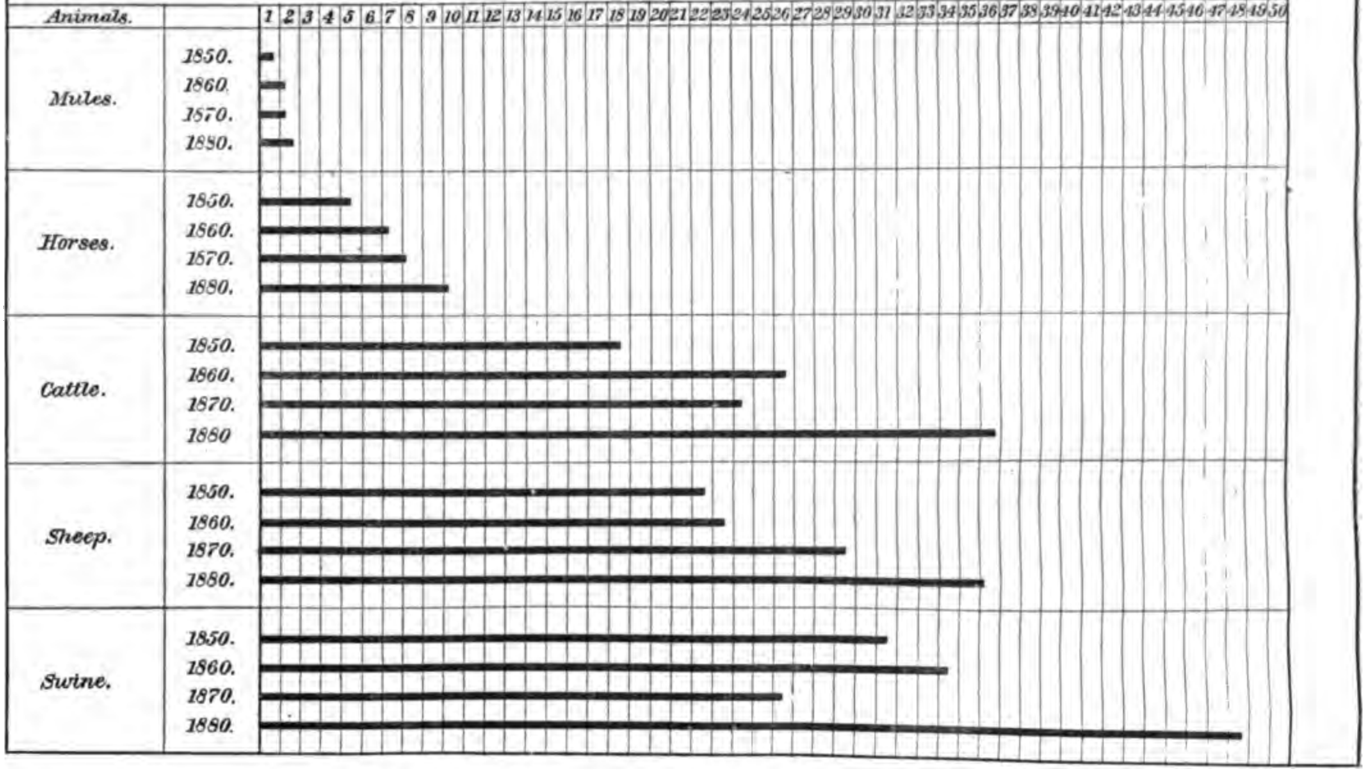
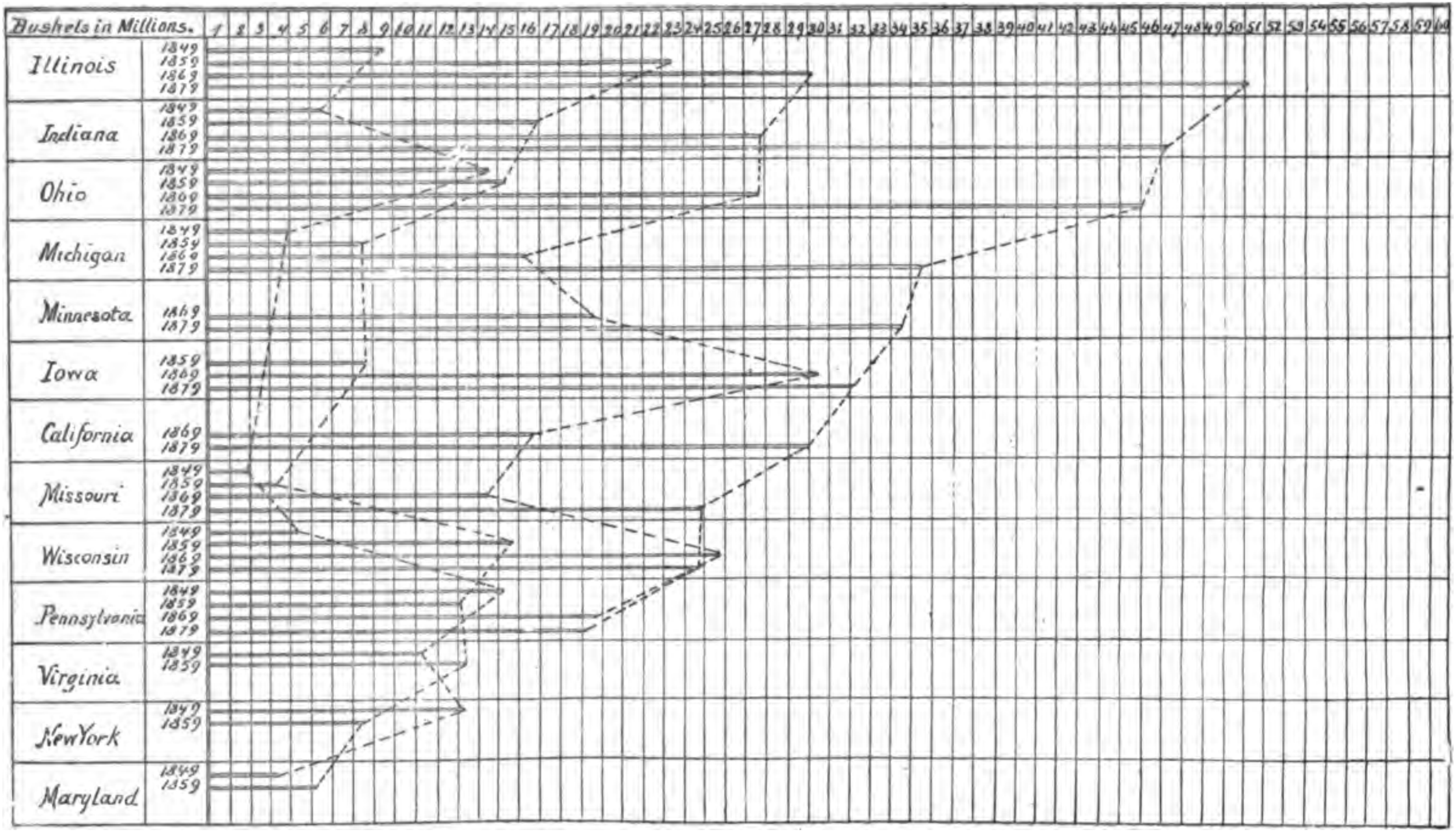


DIAGRAM VIII.

Progress of wheat production in thirty years.



VALUES OF FARM ANIMALS.

Diagram VI illustrates the comparative value of the animals of the farm, in 1884, by a circle which represents the aggregate value, while segments of the same, in different colors, show the relative proportion of each kind of animals. The prominence of the cattle interest is strikingly manifest, being 44.8 per cent. of the aggregate. Horses come next, with 33.8 per cent.; swine, 10; mules, 6.5; sheep, 4.9.

The values are as follows:

Horses	$833,734,400
Mules	161,214,976
Cattle	1,106,715,703
Sheep	119,902,706
Swine	246,301,139
Total	2,467,859,924

INCREASE OF FARM ANIMALS IN THIRTY YEARS.

Diagram VII shows the comparative numbers of horses, mules, cattle, sheep, and swine, at four decennial periods. The differences are shown by horizontal lines. The numbers are thus presented:

Stock.	1850.	1860.	1870.	1880.
Horses	4,336,719	6,249,174	7,145,370	10,357,488
Mules	559,331	1,151,148	1,125,415	1,812,808
Cattle	17,778,907	25,620,019	23,820,608	35.925,511
Sheep	21,723.220	22,471.275	28,477,951	35.192,074
Swine	30,354,213	33,512,867	25,134,569	47,681,700

This table includes only the stock of farms, exclusive of ranches. Were animals or ranches included, the cattle and sheep of 1880 would be largely increased, and those of 1870 slightly. At the other dates, the ranch interest was scarcely appreciable.

PROGRESS OF WHEAT PRODUCTION IN THIRTY YEARS.

Diagram VIII compares wheat production in the ten States of highest rank in wheat-growing at each decimal census, from 1850 to 1880, and delineates conspicuously the extraordinary advance of Missouri, Ohio, Michigan, Minnesota, Iowa, and California. Two States in the list for 1879 exceed in production the whole ten of the 1849 list, and nearly equal entire crop of that year. The changes of this short period are wonderful; three States of the first list fail to appear in the ten of largest production in 1879. Pennsylvania, which was first in rank in 1849, was tenth (and last of the list) in 1879. Ten States in 1849 produced 86 per cent. of the crop; in 1859, ten produced 75 per cent.; in 1869, the list of ten represents 79 per cent., and that of 1879 three-

fourths of the production of the country. The following tables are the basis of the diagram:

States.	1849.	States.	1859.
	Bushels.		*Bushels.*
Pennsylvania	15,367,691	Illinois	[illegible]
Ohio	14,487,351	Indiana	16,[illegible]
New York	13,121,498	Wisconsin	15,[illegible]
Virginia	11,212,616	Ohio	15,[illegible]
Illinois	9,414,575	Virginia	13,[illegible]
Indiana	6,214,458	Pennsylvania	13,[illegible]
Michigan	4,925,889	New York	8,[illegible]
Maryland	4,494,680	Iowa	8,[illegible]
Wisconsin	4,286,131	Michigan	8,33[illegible]
Missouri	2,981,652	Maryland	6,10[illegible]
Total	86,506,541	Total	129,[illegible]

States.	1869.	States.	1879.
	Bushels		*Bushels.*
Illinois	30,128,405	Illinois	51,110,[illegible]
Iowa	29,435,692	Indiana	47,284,[illegible]
Ohio	27,882,159	Ohio	46,014,[illegible]
Indiana	27,747,222	Michigan	35,532,[illegible]
Wisconsin	25,606,344	Minnesota	34,601,[illegible]
Pennsylvania	19,672,967	Iowa	31,154,[illegible]
Minnesota	18,866,073	California	29,017,[illegible]
California	16,676,702	Missouri	24,966,[illegible]
Michigan	16,265,773	Wisconsin	24,884,[illegible]
Missouri	14,315,926	Pennsylvania	19,462,[illegible]
Total	226,597,263	Total	344,[illegible]

The diagram brings out the fact, so generally unappreciated or unnoted, that the principal wheat region of the country is the Ohio Valley, and not the "Northwest," or the Pacific States. The undue prominence of a single crop in a State by no means fixes its rank in production.

YIELD PER ACRE OF WHEAT.

Diagram IX shows the difference in rate of yield of the States and Territories in 1879. The Ohio Valley makes the largest yields, New England about the same as the Pacific coast, and the spring-wheat region much less. The average rate of yield is small in the South, though there are instances of very heavy yields, indicating the possibilities of certain soils in that region from wheat production.

States.	Yield per acre.	States.	Yield per acre.	States.	Yield per acre.
Maine	15.2	South Carolina	5.6	Indiana	18.[illegible]
New Hampshire	15.0	Georgia	6.6	Illinois	15.[illegible]
Vermont	16.3	Florida	5.2	Wisconsin	12.[illegible]
Massachusetts	16.4	Alabama	5.7	Minnesota	11.4
Rhode Island	14.1	Mississippi	5.0	Iowa	10.3
Connecticut	17.6	Louisiana	3.4	Missouri	12.0
New York	15.7	Texas	6.8	Kansas	9.3
New Jersey	12.7	Arkansas	6.2	Nebraska	9.4
Pennsylvania	13.5	Tennessee	6.1	California	22.0
Delaware	13.4	West Virginia	10.2	Oregon	15.[illegible]
Maryland	14.1	Kentucky	9.8	Nevada	16.[illegible]
Virginia	8.7	Ohio	18.0	Colorado	18.[illegible]
North Carolina	5.2	Michigan	18.5		

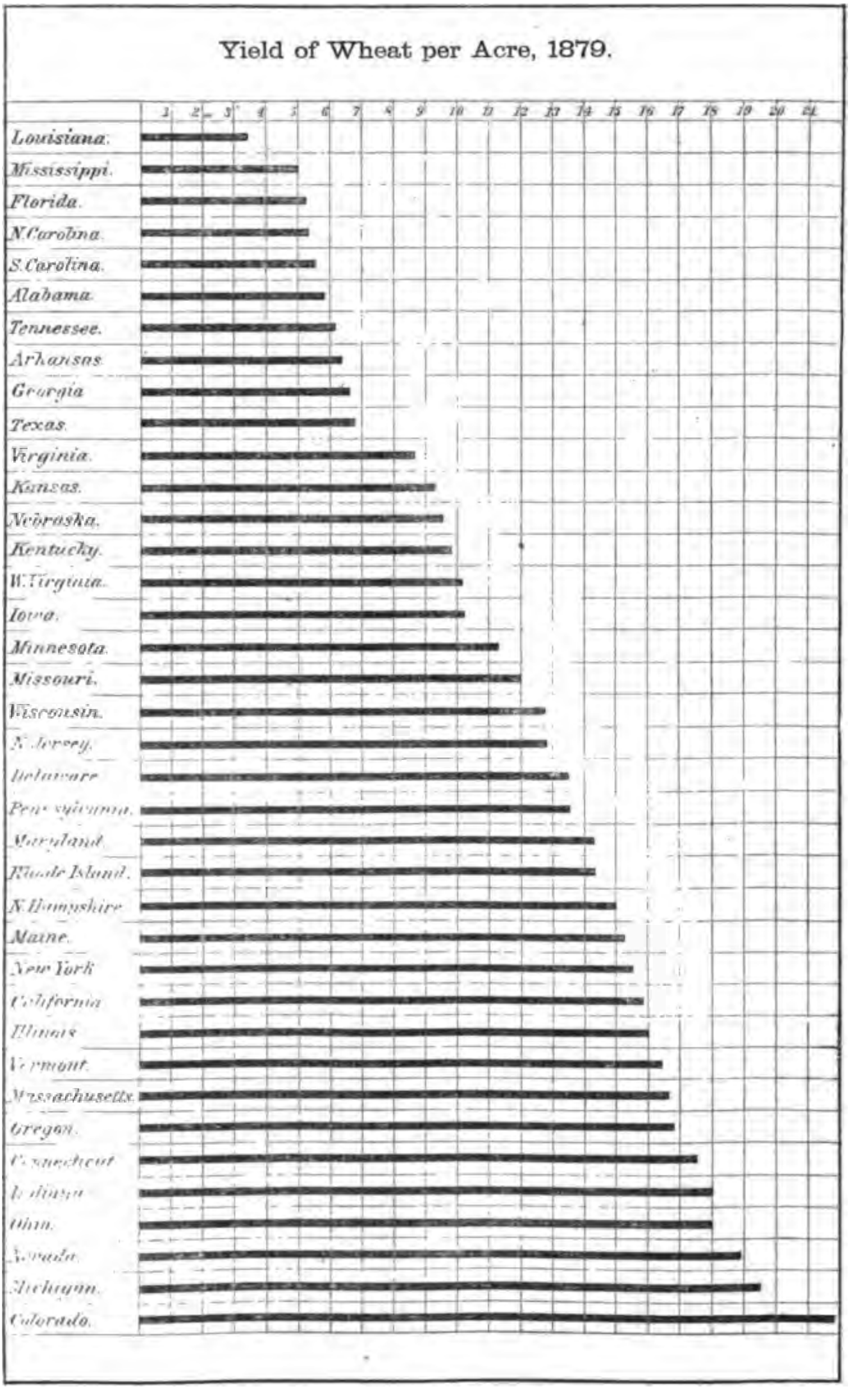
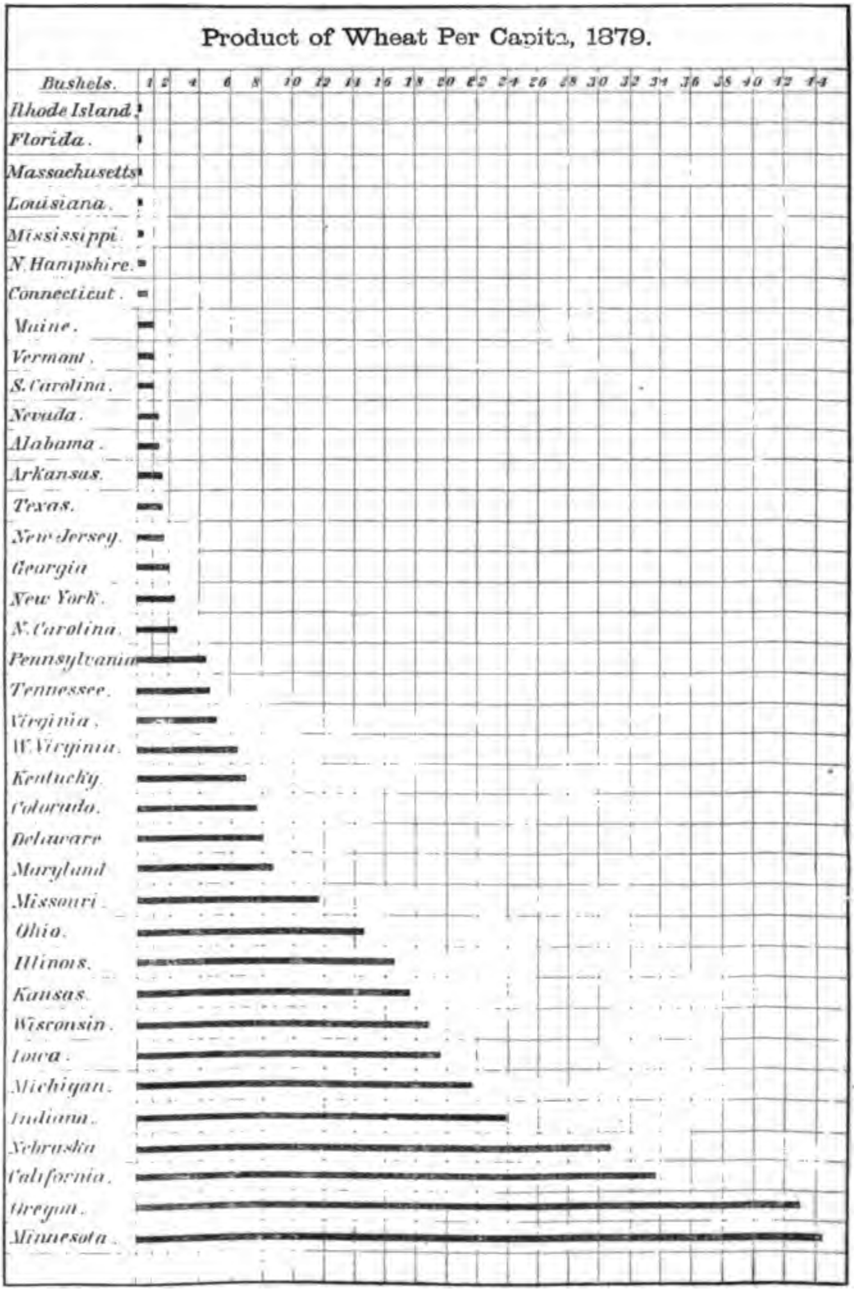

Yield of Wheat per Acre, 1879.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
Louisiana.
Mississippi.
Florida.
N.Carolina.
S.Carolina.
Alabama.
Tennessee.
Arkansas.
Georgia.
Texas.
Virginia.
Kansas.
Nebraska.
Kentucky.
W.Virginia.
Iowa.
Minnesota.
Missouri.
Wisconsin.
Delaware.
Maryland.
Maine.
New York
California
Illinois
Vermont.
Massachusetts.
Oregon.
Ohio.
Michigan.
Colorado.

DIAGRAM X.


Product of Wheat Per Capita, 1879.
Bushels.
1 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44
Rhode Island
Florida
Massachusetts
Louisiana
Mississippi
N. Hampshire
Connecticut
Maine
Vermont
S. Carolina
Nevada
Alabama
Arkansas
Texas
New Jersey
Georgia
New York
N. Carolina
Pennsylvania
Tennessee
Virginia
W. Virginia
Kentucky
Colorado
Delaware
Maryland
Missouri
Ohio
Illinois
Kansas
Wisconsin
Iowa
Michigan
Indiana
Nebraska
California
Oregon
Minnesota

QUANTITY

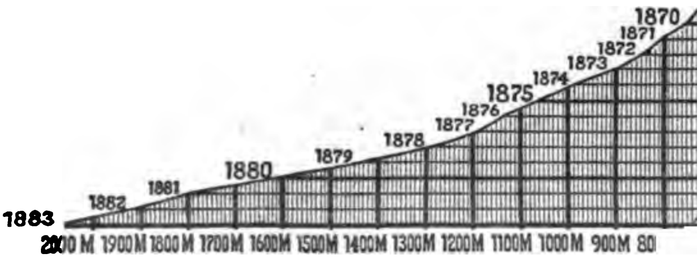
BUSHELS

Scale:

1/4th inch to 100 millions.

WHEAT ......

FLOUR ......



PRODUCT OF WHEAT PER HEAD.

The relative prominence of wheat, as a crop, in the several political divisions, is shown by Diagram X. It illustrates the extremes of supply, from little more than half a pint to each inhabitant in Louisiana to forty-four bushels in Minnesota. It exhibits in a glaring light one aspect of specialties in agriculture, or one-idea farming. The product per head for each division in 1879 was as follows:

States.	Product per capita.	States.	Product per capita.	States.	Product per capita.
Maine	1.0	South Carolina	1.0	Indiana	23.9
New Hampshire	.5	Georgia	2.0	Illinois	16.6
Vermont	1.0	Florida	.002	Wisconsin	18.9
Massachusetts	.01	Alabama	1.2	Minnesota	44.3
Rhode Island	.001	Mississippi	.2	Iowa	19.2
Connecticut	.6	Louisiana	.01	Missouri	11.5
New York	2.3	Texas	1.6	Kansas	17.4
New Jersey	1.7	Arkansas	1.6	Nebraska	30.6
Pennsylvania	4.5	Tennessee	4.8	California	7.3
Delaware	8.0	West Virginia	6.5	Oregon	33.6
Maryland	8.6	Kentucky	6.9	Nevada	42.9
Virginia	5.2	Ohio	14.4	Colorado	1.1
North Carolina	2.4	Michigan	21.7		

EXPORTATION OF WHEAT IN FIFTY-EIGHT YEARS.

Diagram XI presents a pyramidal form illustrating both quantity and value of wheat exported since 1825, the base line measuring the value in millions of dollars on the right, and the quantity in millions of bushels on the left, while the horizontal bars furnish new bases for similar measurements for each period of five years.

The diagram also shows separately the wheat and flour exported, the latter of course reduced to bushels of wheat. Fifty years ago the exports were mainly flour; in later years grain has so preponderated that in the whole period more than six-tenths have been in unmanufactured wheat. The entire value exceeds two and a half billions of dollars; enough to buy one-fourth of the farms of the United States. Half of this value is represented by the shipments of nine years; in a single year the export has surpassed in value all the foreign trade in wheat from 1825 to 1860. The trade has been an extraordinary development, principally of a few years of European scarcity from a series of crop failures. This sudden movement has been checked, and a sharp retrograde has resulted from better crops in foreign countries, causing heavy reduction in prices of wheat. While there is no probability in European counties, of a home supply equal to that of thirty years ago, there is no prospect of high prices for wheat in the immediate future.

The exhibit is founded on the following data, compiled from (records of exportation:

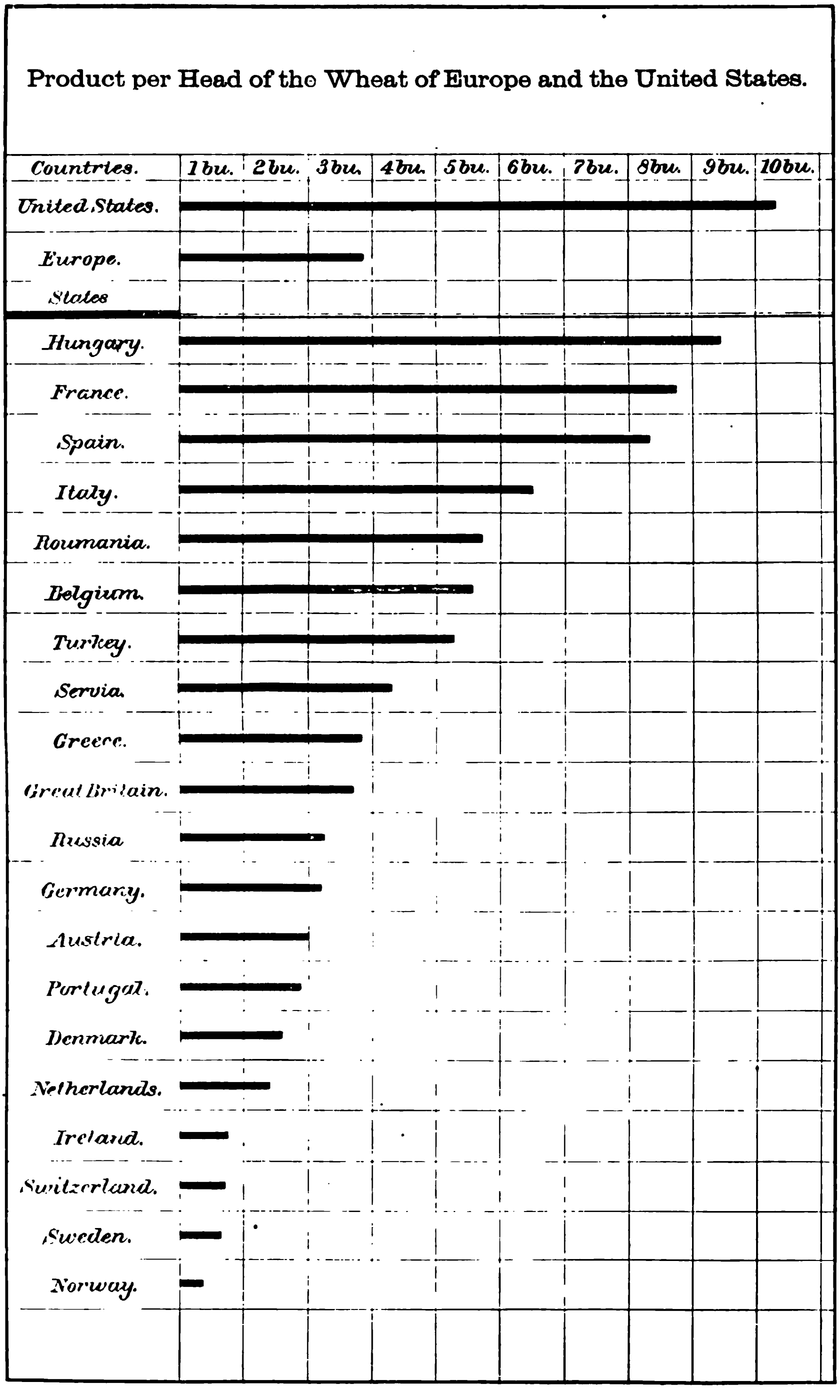
Quantity of exports of wheat and flour.

Years.	Wheat.		Flour.		Total wheat and flour.	
	Bushels.	Bushels.	Bushels.	Bushels.	Bushels.	Bushels.
1830	125, 547		23, 259, 700		23, 385, 247	
1835	614, 145		26, 209, 820		26, 823, 965	
		739, 692		49, 469, 520		50, 209, 21[illegible]
	739, 692		49, 469, 520		50, 209, 212	
1840	1, 842, 841		20, 464, 660		22, 307, 501	
		2, 582, 533		69, 934, 180		72, 516, 71[illegible]
	2, 582, 533		69, 934, 180		72, 516, 713	
1845	2, 946, 861		31, 373, 485		34, 320, 346	
		5, 529, 394		101, 307, 665		10[illegible]
	5, 529, 394		101, 307, 665		106, 837, 059	
1850	10, 184, 645		61, 424, 140		71, 608, 785	
		15, 714, 039		162, 731, 805		178, 445, 84[illegible]
	15, 714, 039		162, 731, 805		178, 445, 844	
1855	16, 446, 955		65, 747, 590		82, 194, 545	
		32, 160, 904		228, 479, 395		26[illegible]
	32, 160, 904		228, 479, 395		260, 640, 389	
1860	38, 808, 573		78, 891, 340		117, 699, 913	
		70, 969, 567		307, 370, 735		378, [illegible]
	70, 969, 567		307, 370, 735		378, 340, 302	
1865	138, 306, 907		98, 788, 665		237, 095, 572	
		209, 276, 474		406, 159, 400		615, 435, 8[illegible]
	209, 276, 474		406, 159, 400		615, 435, 874	
1870	81, 808, 364		57, 273, 925		139, 082, 289	
		291, 084, 838		463, 433, 325		754, 518, 1[illegible]
	291, 084, 838		463, 433, 325		754, 518, 163	
1875	224, 019, 374		83, 878, 210		307, 897, 584	
		515, 104, 212		547, 311, 535		1, 062, 415, 7[illegible]
	515, 104, 212		547, 311, 535		1, 062, 415, 747	
1876	55, 073, 122		17, 709, 804		72, 782, 926	
		570, 177, 334		565, 021, 339		1, 135, 198, 6[illegible]
	570, 177, 334		565, 021, 339		1, 135, 198, 673	
1877	40, 325, 611		15, 046, 492		55, 372, 103	
		610, 502, 945		580, 067, 831		1, 190, 570, 776
	610, 502, 945		580, 067, 831		1, 190, 570, 776	
1878	72, 404, 961		17, 762, 998		90, 167, 959	
		682, 907, 906		597, 830, 829		1, 280, 738, 735
	682, 907, 906		597, 830, 829		1, 280, 738, 735	
1879	122, 353, 936		25, 333, 713		147, 687, 649	
		805, 261, 842		623, 164, 542		1, 428, 426, 384
	805, 261, 842		623, 164, 542		1, 428, 426, 384	
1880	153, 252, 795		27, 051, 385		180, 304, 180	
		958, 514, 637		650, 215, 927		1, 608, 730, 564
	958, 514, 637		650, 215, 927		1, 608, 730, 564	
1881	150, 565, 477		35, 756, 037		186, 321, 514	
		1, 109, 080, 114		685, 971, 964		1, 795, 052, 078
	1, 109, 080, 114		685, 971, 964		1, 795, 052, 078	
1882	95, 271, 802		26, 620, 587		121, 892, 389	
		1, 204, 351, 916		712, 592, 551		1, 916, 944, 467
	1, 204, 351, 916		712, 592, 551		1, 916, 944, 467	
1883	106, 385, 828		41, 425, 488		147, 811, 316	
		1, 310, 737, 744		754, 018, 039		2, 064, 755, 783
Total	1, 310, 737, 744		754, 018, 039		2, 064, 755, 783	

Value of exports of wheat and flour.

Years.	Wheat.		Flour.		Total value of wheat and flour.
	Value.	Value.	Value.	Value.	
1830	$112, 754	....	$24, 708, 090	....	$24, 820, 844
1835	737, 365		29, 347, 649	$54, 055, 739	
		$850, 119			54, 905, 858
	850, 119		54, 055, 739		
1840	1, 817, 067		27, 231, 952		
		2, 667, 186		81, 287, 691	83, 954, 877
	2, 667, 186		81, 287, 691		

Product per Head of the Wheat of Europe and the United States.



Value of exports of wheat and flour—Continued.

Years.	Wheat. Value.	Wheat. Value.	Flour. Value.	Flour. Value.	Total value of wheat and flour.
1845	$2,900,785		$31,056,156		
		$5,567,971		$112,343,847	$117,911,818
1850	5,567,971 12,801,093		112,343,847 69,375,741		
		18,369,064		181,719,588	200,088,652
1855	18,369,064 21,864,762		181,719,588 75,775,220		
		40,233,826		257,494,808	297,728,634
1860	40,233,826 53,343,918		257,494,808 104,368,446		
		93,577,744		361,863,254	455,440,998
1865	93,577,744 178,470,444		361,863,254 133,356,875		
		272,048,188		495,220,129	767,268,317
1870	272,048,188 117,527,424		495,220,129 92,071,717		
		389,575,612		587,291,846	976,867,458
1875	389,575,612 296,540,060		587,291,846 114,398,700		
		686,115,672		701,690,546	1,387,806,218
1876	686,115,672 68,382,899		701,690,546 24,433,470		
		754,498,571		726,124,016	1,480,622,587
1877	754,408,571 47,135,562		726,124,016 21,663,947		
		801,634,133		747,787,963	1,549,422,096
1878	801,634,133 96,872,016		747,787,963 25,095,721		
		898,506,149		772,883,684	1,671,389,833
1879	898,506,149 130,701,079		772,883,684 29,567,713		
		1,029,207,228		802,451,397	1,831,658,625
1880	1,029,207,228 190,546,305		802,451,397 35,333,197		
		1,219,753,533		837,784,594	2,057,538,127
1881	1,219,753,533 167,698,485		837,784,594 45,047,257		
		1,387,452,018		882,831,851	2,270,283,869
1882	1,387,452,018 112,929,718		882,831,851 36,375,055		
		1,500,381,736		919,206,906	2,419,588,642
1883	1,500,381,736 119,879,341		919,206,906 54,824,459		
		1,620,261,077		974,031,365	2,594,292,442
Total	1,020,261,077		974,031,365		

PRODUCT PER HEAD OF THE WHEAT OF EUROPE AND UNITED STATES.

The comparative production of wheat in this and European countries in relation to population is the subject of Diagram XII. It does not include supplies by importation, but shows what is done by farmers of each country to supply the population of each. It is shown by the common linear method, the number of bushels per head being indicated by horizontal lines, which are crossed by perpendicular lines to mark the number of bushels.

There are features in this exhibit calculated to surprise the uninitiated. For instance, Russia, the principal competitor of this country in wheat exportation, has only 2.1 bushels per head, while the United States had 9.2 in 1879, the census year. The reason is Russia exports wheat and eats but little of it, using rye instead. Germany has the same relative supply, and she uses rye rather than wheat for bread. Hungary, France, and Spain stand in the front rank as to supply per head.

The following table shows the quantity produced, the population, and rate of supply in the states of Europe:

Countries.	Wheat.	Per head.	Population.
	Bushels.		
Austria	44,543,126	2.0	22,316,5[illegible]
Hungary	131,746,878	8.4	15,642,1[illegible]
Belgium	24,990,030	4.5	5,58[illegible]
Denmark	3,102,821	1.5	2,018,[illegible]
France	204,400,346	7.8	37,672,[illegible]
Germany	93,823,048	2.1	45,[illegible]
Great Britain	82,265,783	2.7	30,[illegible]
Ireland	3,874,155	.8	5,[illegible]
Greece	4,370,649	2.8	1,[illegible]
Italy	155,012,168	5.4	28,[illegible]
Netherlands	5,439,533	1.3	4,17[illegible]
Portugal	7,597,088	1.9	3,99[illegible]
Roumania	25,000,000	4.7	5,37[illegible]
Russia	171,389,856	2.1	83,60[illegible]
Servia	4,086,720	3.3	1,250,00[illegible]
Spain	117,563,372	7.3	16,000,00[illegible]
Sweden	3,106,779	.7	4,579,11[illegible]
Norway	284,703	.2	1,818,8[illegible]
Switzerland	2,145,528	.8	2,669,1[illegible]
Turkey	40,867,200	4.2	9,800,00[illegible]
Total for Europe	1,215,609,783	3.7	327,020,1[illegible]
Total for United States (1879)	459,483,137	9.2	50,155,7[illegible]

YIELD OF CORN IN 1879 AND 1883 IN GROUPS OF STATES.

Diagram XIII compares, by groups of States, the corn yield of 1879 and 1883. It is as follows:

Group.	1879.	1883.
Trans-Mississippi States	37.5	[illegible]
New England States	34.3	[illegible]
New York, New Jersey, and Pennsylvania	33.2	[illegible]
Ohio basin	32.9	[illegible]
Pacific slope	27.4	[illegible]
Rocky Mountain region	19.5	[illegible]
Delaware, Maryland, and Virginia	18.6	[illegible]
Gulf Southern States	15.6	[illegible]
Atlantic Southern States	10.2	9.5

ANNUAL VARIATION IN YIELD OF CORN.

Diagram XIV shows the average yield per acre of the entire area in corn, as estimated for fourteen years past. It shows that five crops have been under the average rate of yield (of 26 bushels), seven over an average, and two, 1876 and 1884, as near as possible to such average. Only two years in the ten between 1870 and 1880 had short crops, with only one since that rose to a medium rate of yield. The figures are as follows:

Years.	Yield per acre.	Years.	Yield per acre.	Years.	Yield per acre.
1871	29.1	1876	26.1	1881	18.6
1872	30.7	1877	26.6	1882	24.6
1873	23.8	1878	26.9	1883	22.7
1874	20.7	1879	29.2	1884	26.6
1875	29.4	1880	27.6		

DIAGRAM XV.

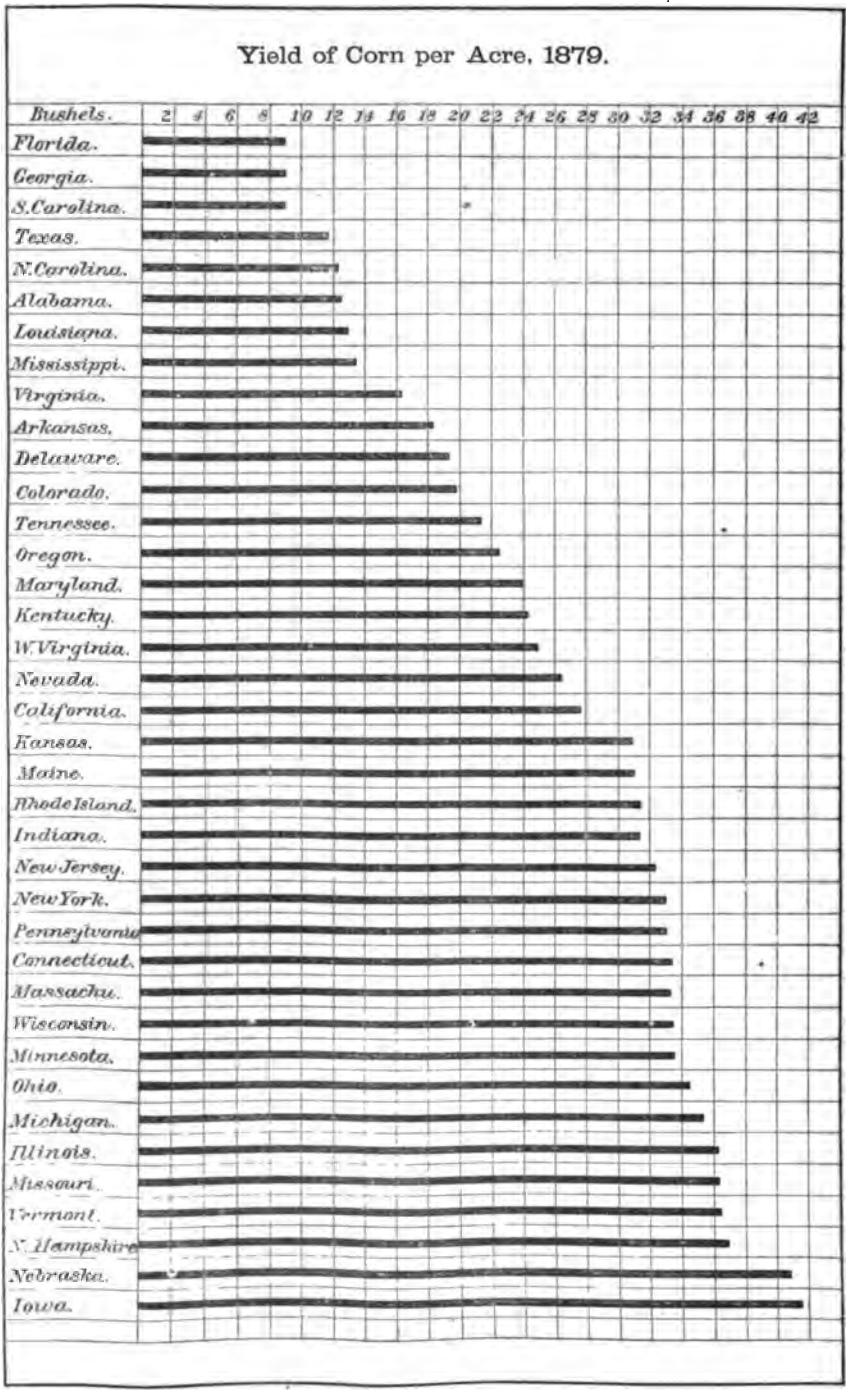

Yield of Corn per Acre, 1879.
Bushels.
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42
Florida.
Georgia.
S. Carolina.
Texas.
N. Carolina.
Alabama.
Louisiana.
Mississippi.
Virginia.
Arkansas.
Delaware.
Colorado.
Tennessee.
Oregon.
Maryland.
Kentucky.
W. Virginia.
Nevada.
California.
Kansas.
Maine.
Rhode Island.
Indiana.
New Jersey.
New York.
Pennsylvania
Connecticut.
Massachu.
Wisconsin.
Minnesota.
Ohio.
Michigan.
Illinois.
Missouri.
Vermont.
N. Hampshire
Nebraska.
Iowa.

DIAGRAM XVI.

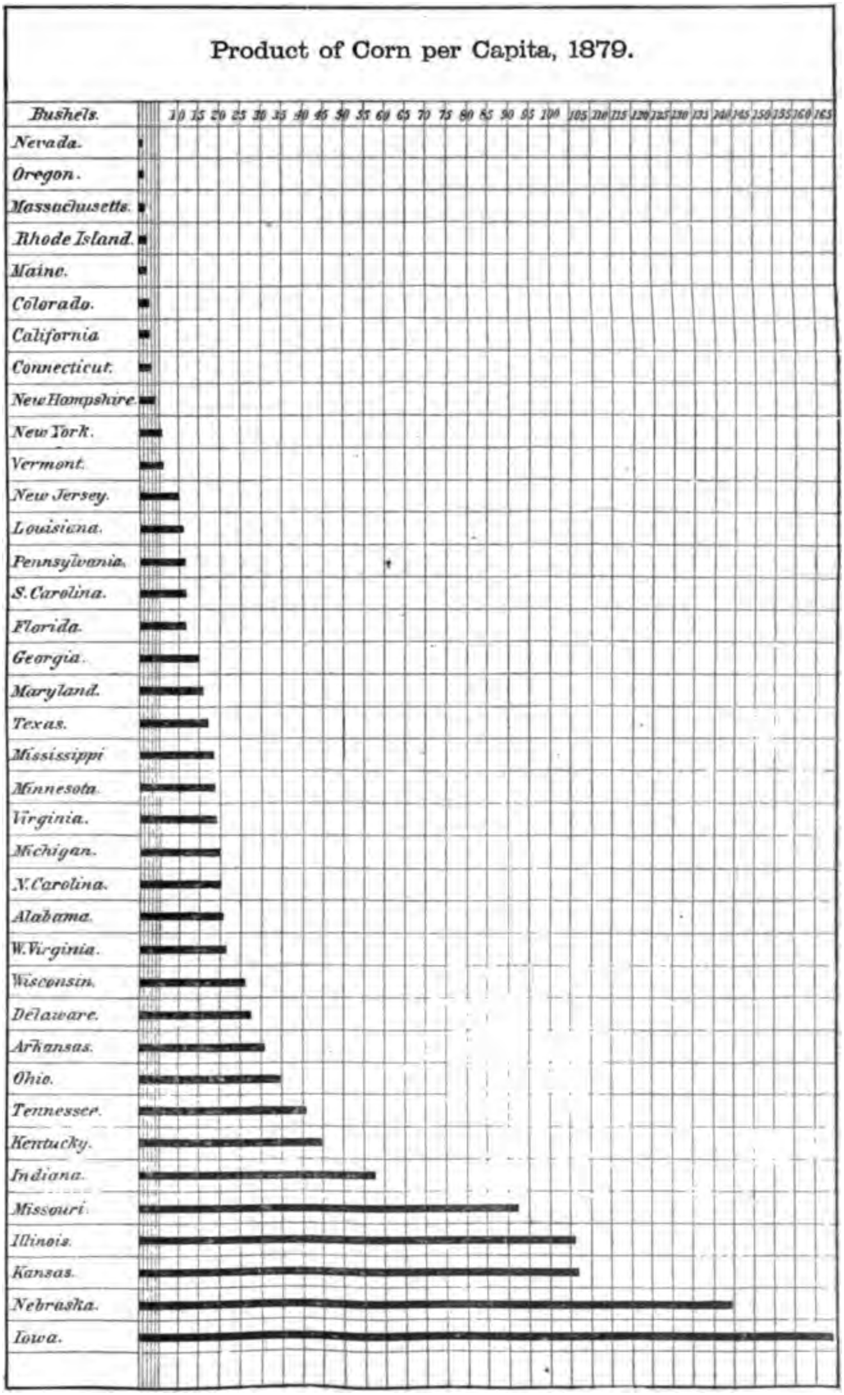
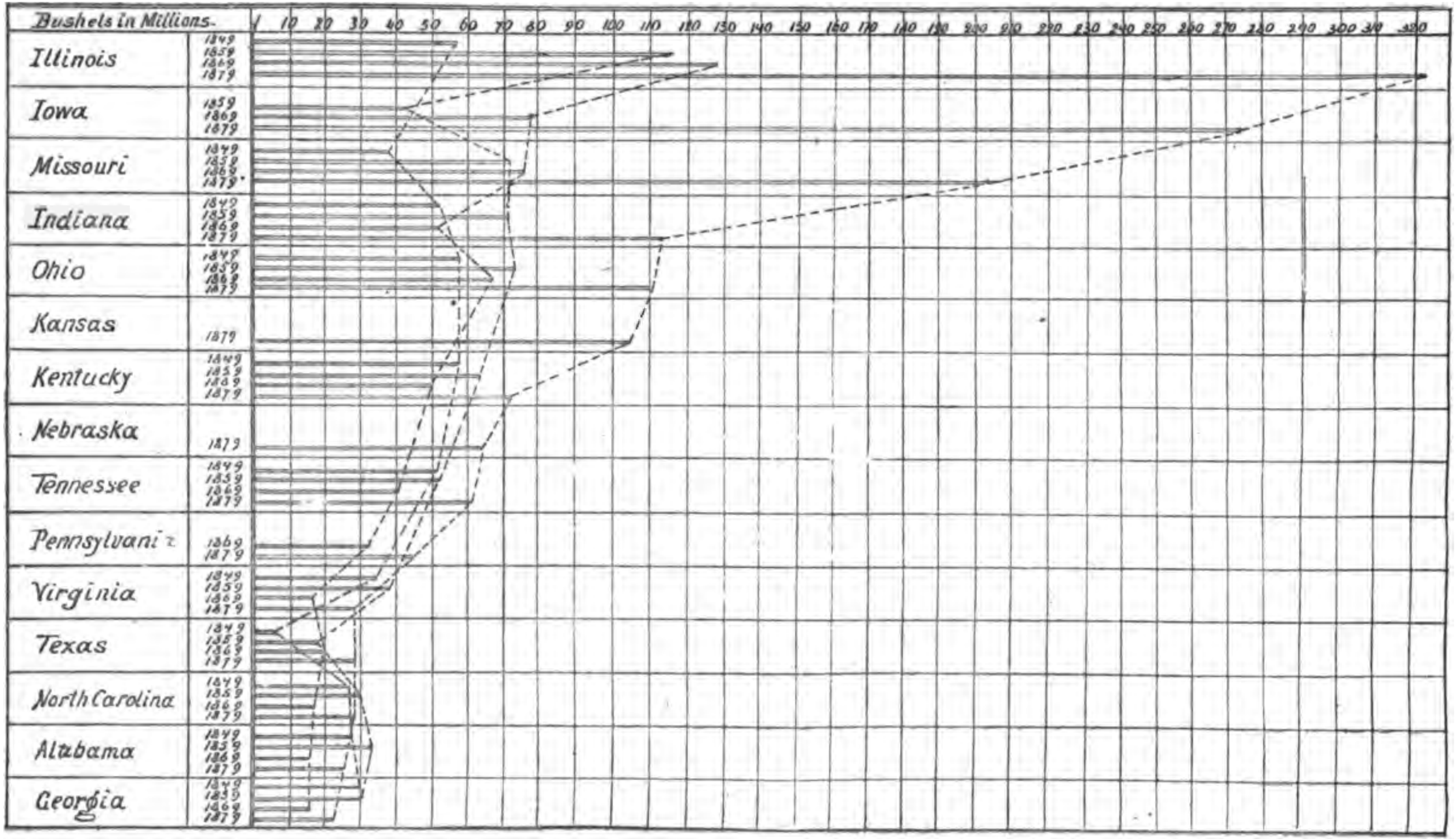

Product of Corn per Capita, 1879.
Bushels.
10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160 165
Nevada.
Oregon.
Massachusetts.
Rhode Island.
Maine.
Colorado.
California
Connecticut.
New Hampshire.
New York.
Vermont.
New Jersey.
Louisiana.
Pennsylvania.
S. Carolina.
Florida.
Georgia.
Maryland.
Texas.
Mississippi
Minnesota
Virginia.
Michigan.
N. Carolina.
Alabama.
W. Virginia.
Wisconsin.
Delaware.
Arkansas.
Ohio.
Tennessee.
Kentucky.
Indiana.
Missouri.
Illinois.
Kansas.
Nebraska.
Iowa.

DIAGRAM XVII.

Progress of corn production in thirty years.



YIELD PER ACRE OF CORN.

Diagram XV indicates, by States, the yield per acre of corn in the last census year. There are annual variations in yield, from drought or other causes, so that the State which occupies the first place in a given year may be preceded by several States in the following season. In 1879 Iowa stood first and Nebraska second in rank. The basis of this diagram is as follows:

States.	Yield per acre.	States.	Yield per acre.	States.	Yield per cent.
Maine	31.0	South Carolina	9.0	Indiana	31.4
New Hampshire	36.9	Georgia	9.0	Illinois	36.1
Vermont	36.5	Florida	8.8	Wisconsin	33.7
Massachusetts	33.7	Alabama	12.4	Minnesota	33.8
Rhode Island	31.4	Mississippi	13.6	Iowa	41.6
Connecticut	33.7	Louisiana	13.3	Missouri	36.2
New York	33.2	Texas	11.8	Kansas	30.9
New Jersey	32.4	Arkansas	18.6	Nebraska	40.1
Pennsylvania	33.4	Tennessee	21.6	California	27.8
Delaware	19.3	West Virginia	24.9	Oregon	22.5
Maryland	24.0	Kentucky	24.1	Nevada	26.5
Virginia	16.5	Ohio	34.1	Colorado	19.8
North Carolina	12.2	Michigan	35.3		

PRODUCT PER HEAD OF CORN.

The distribution of corn is general. There is no State or Territory in which it is not grown, yet in Massachusetts in 1879 the product is only one bushel to each inhabitant, while 169 bushels per head were grown in Iowa. Nebraska, Kansas, and Illinois are next in rank, each having a supply exceeding one hundred bushels to each inhabitant, or five hundred bushels to each family. Only one other State has half as much; Indiana has fifty-eight. The supply is thus given by States in Diagram XVI:

States.	Supply per head.	States.	Supply per head.	States.	Supply per head.
Maine	1.5	South Carolina	11.8	Indiana	58.4
New Hampshire	3.9	Georgia	15.0	Illinois	105.9
Vermont	6.1	Florida	11.8	Wisconsin	26.0
Massachusetts	1.0	Alabama	20.2	Minnesota	19.0
Rhode Island	1.3	Mississippi	18.8	Iowa	169.3
Connecticut	3.0	Louisiana	10.5	Missouri	93.4
New York	5.1	Texas	18.3	Kansas	106.1
New Jersey	9.9	Arkansas	30.1	Nebraska	144.7
Pennsylvania	10.7	Tennessee	40.7	California	2.3
Delaware	26.6	West Virginia	22.8	Oregon	0.7
Maryland	17.1	Kentucky	44.2	Nevada	0.2
Virginia	19.2	Ohio	34.9	Colorado	2.3
North Carolina	20.0	Michigan	19.8		

PROGRESS OF CORN PRODUCTION.

Diagram XVII presents in graphic outline the movement of corn-growing in thirty years, at four decennial periods, in ten States of principal production, at each census. It shows the center of production moving northward as well as westward. In 1849 six-tenths of the crop

was grown in the South; in 1879 the only Southern States included in the list of ten years' principal production were Tennessee, Kentucky, and Missouri, while thirty years before only Ohio, Indiana, and Illinois were in the Northern list. An examination of the figures will show great growth and remarkable changes.

No.	States.	1849.	No.	States.	1859.
		Bushels.			*Bushels.*
1	Ohio	59,078,695	1	Illinois	115,174,7[illegible]
2	Kentucky	58,672,591	2	Ohio	73,543,1[illegible]
3	Illinois	57,646,984	3	Missouri	72,892,1[illegible]
4	Indiana	52,964,363	4	Indiana	71,588,9[illegible]
5	Tennessee	52,276,223	5	Kentucky	64,043,6[illegible]
6	Missouri	36,214,537	6	Tennessee	52,089,9[illegible]
7	Virginia	35,254,319	7	Iowa	42,410,6[illegible]
8	Georgia	30,080,099	8	Virginia	38,319,[illegible]
9	Alabama	28,754,048	9	Alabama	33,22[illegible]
10	North Carolina	27,941,051	10	Georgia	30,77[illegible]

No.	States.	1869.	No.	States.	1879.
		Bushels.			*Bushels.*
1	Illinois	129,921,395	1	Illinois	325,792,4[illegible]
2	Iowa	68,935,065	2	Iowa	275,024,2[illegible]
3	Ohio	67,501,144	3	Missouri	202,485,7[illegible]
4	Missouri	66,034,075	4	Indiana	115,482,3[illegible]
5	Indiana	51,094,538	5	Ohio	111,877,1[illegible]
6	Kentucky	50,091,006	6	Kansas	105,72[illegible]
7	Tennessee	41,343,614	7	Kentucky	72,85[illegible]
8	Pennsylvania	34,702,006	8	Nebraska	65,45[illegible]
9	Texas	20,554,538	9	Tennessee	62,76[illegible]
10	North Carolina	18,454,215	10	Pennsylvania	45,82[illegible]

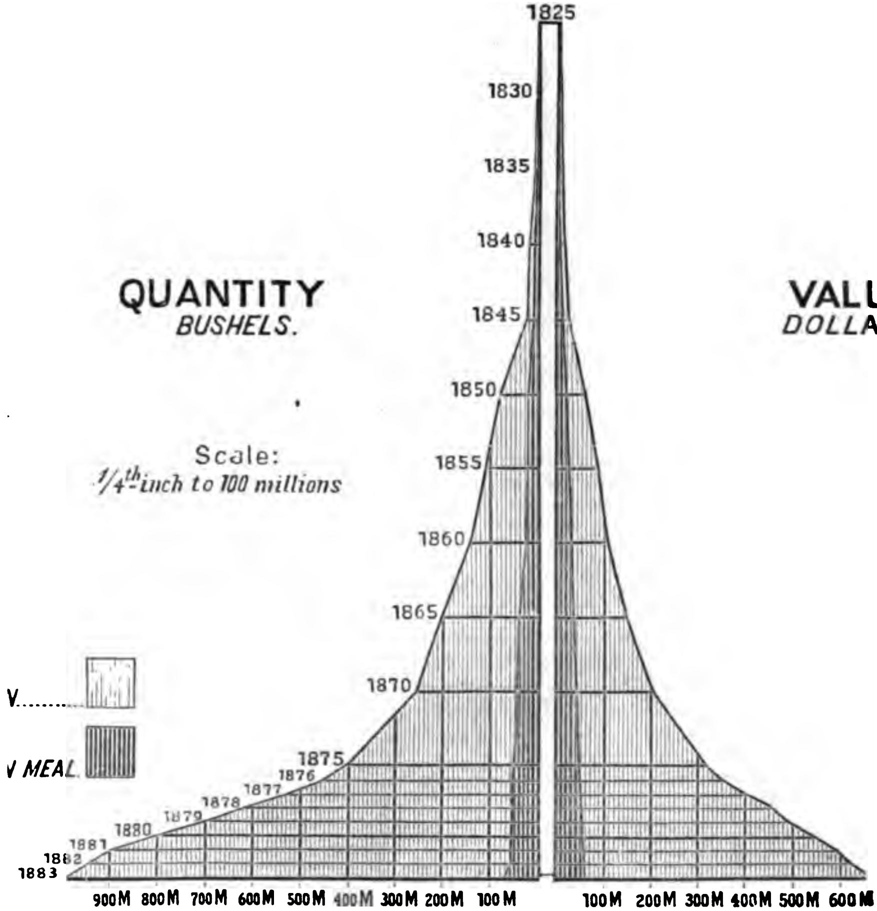
The proportion produced, respectively, by the ten principal corn-growing States was as follows:

	Crop of ten principal States.	Per cent.	Crop of United States.
	Bushels.		*Bushels.*
1849	438,882,910	74.1	592,071,1[illegible]
1859	594,065,862	70.8	838,792,7[illegible]
1869	548,631,596	72.1	760,944,5[illegible]
1879	1,383,279,538	78.8	1,754,591,6[illegible]

EXPORTATION OF CORN IN FIFTY-EIGHT YEARS.

Diagram XVIII, a figure upon the same plan and scale as that illustrating the exportation of wheat, shows a similar rapidity of development in foreign trade in recent years, though the volume of shipments is small compared with wheat. The exports of the whole period are little more than half of one year's production at the present time, being less than a billion bushels, valued at 65.7 cents per bushel. The annual shipments fluctuate with the price, from two million bushels when prices are high, to one hundred millions when corn is cheapest, disproving the statement that Liverpool fixes the values of all our products which happen to be marketed there in part. On the contrary, in the corn trade, domestic prices control foreign shipments. It is another illustration of the fallacy of certain trite assumptions in popular dicta of po-

Export of corn in fifty-eight years.



litical economy. It is the law of supply and demand that governs, and where the foreign demand is a trifle its effect is scarcely appreciable. Besides, this small demand is itself almost entirely dependent on price, as the product is not indispensable.

The following tables give the details of this exportation in annual or quinquennial periods:

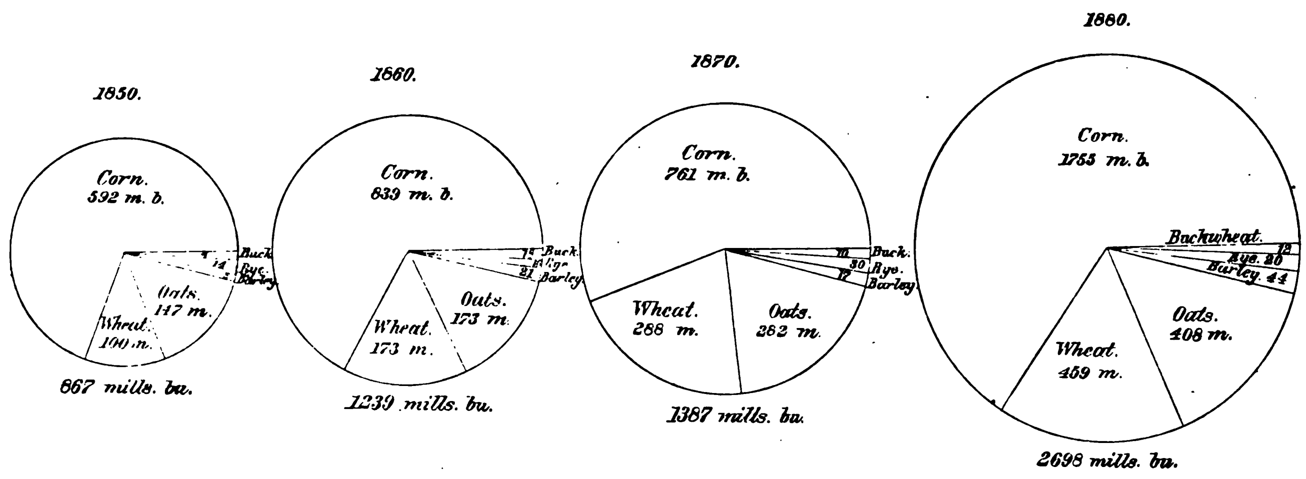
Quantity of exports of corn and corn-meal.

Years.	Corn.		Corn-meal.		Total bushels.
	Bushels.	Bushels.	Bushels.	Bushels.	
1830 1835	3,530,710 2,568,946	....	3,133,632 3,269,532	....	6,664,342
		6,099,656		6,403,164	12,502,820
1840	6,099,656 1,184,973		6,403,164 3,375,720		
		7,284,629		9,778,884	17,063,513
1845	7,284,629 3,474,109		9,778,884 4,530,996		
		10,758,738		14,309,880	25,068,618
1850	10,758,738 43,822,153		14,309,880 9,974,800		
		54,580,891		24,284,680	78,865,571
1855	54,580,891 23,905,196		24,284,680 4,485,824		
		78,486,087		28,770,504	107,256,591
1860	78,486,087 27,597,896		28,770,504 5,165,368		
		106,083,983		33,935,872	140,019,855
1865	106,083,983 52,612,028		33,935,872 4,706,428		
		158,696,011		38,642,300	197,338,311
1870	158,696,011 47,993,276		38,642,300 5,420,096		
		206,689,287		44,062,396	250,751,683
1875	206,689,287 146,152,915		44,062,396 6,416,212		
		352,842,202		50,478,608	403,320,810
1876	352,842,202 49,493,572		50,478,608 1,416,960		
		402,335,774		51,895,568	454,231,342
1877	402,335,774 70,860,983		51,895,568 1,791,628		
		473,196,757		53,687,196	526,883,953
1878	473,196,757 85,461,098		53,687,196 1,731,012		
		558,637,855		55,418,208	614,076,063
1879	558,657,855 86,296,252		55,418,208 1,588,640		
		644,954,107		57,006,848	701,960,955
1880	644,954,107 98,169,877		57,006,848 1,402,452		
		743,123,984		58,409,300	801,533,284
1881	743,123,981 91,908,175		58,409 300 1,739,972		
		835,032,159		60,149,272	895,181,431
1882	835,032,159 43,184,915		60,149,272 1,155,768		
		878,217,074		61,305,040	939,522,114
1883	878,217,074 40,586,825		61,305,040 1,068,828		
		918,803,899		62,373,868	981,177,767
Total	918,803,899		62,373,868		

Value of exports of corn and corn-meal.

Years.	Corn.		Corn-meal.		Total value of corn an corn-meal.	
	Value.	Value.	Value.	Value.		
1830	$2,019,926		$2,404,371		$4,424,297	
1835	1,804,711		2,731,077		4,535,788	
		$3,824,637		$5,135,448		$8,960,0
1840	3,824,637 873,104		5,135,448 3,471,215		8,960,085 4,344,319	
		4,697,741		8,606,663		13,304,4
1845	4,697,741 1,755,602		8,606,663 3,037,021		13,304,404 4,792,623	
		6,453,343		11,643,684		18,097,0
1850	6,453,343 31,277,920		11,643,684 8,984,252		18,097,027 40,262,172	
		37,731,263		20,627,936		58,359,19
1855	37,731,263 17,712,609		20,627,936 4,147,318		58,359,199 21,860,017	
		55,443,962		24,775,254		80,219,21
1860	55,443,962 19,789,181		24,775,254 4,917,515		80,219,216 24,706,696	
		75,233,143		29,692,769		104,925,91
1865	75,233,143 34,903,365		29,692,769 5,323,270		104,925,912 40,226,635	
		110,136,508		35,016,039		145,
1870	110,136,508 47,143,817		35,016,039 7,345,448		145,152,547 54,488,265	
		157,280,325		42,361,487		
1875	157,280,325 104,464,944		42,361,487 6,461,588		199,641,812 110,926,532	
		261,745,269		48,823,075		
1876	261,745,269 33,265,280		48,823,075 1,305,027		310,568,344 34,570,307	
		295,010,549		50,128,102		345,
1877	295,010,549 41,621,245		50,128,102 1,511,152		345,188,651 43,132,397	
		336,631,794		51,639,254		
1878	336,631,794 48,030,358		51,639,254 1,336,187		388,271,048 49,366,545	
		384,662,152		52,975,441		437
1879	384,662,152 40,655,120		52,975,441 1,052,231		437,637,593 41,707,351	
		425,317,272		54,027,672		479,344,
1880	425,317,272 53,298,247		54,027,672 981,361		479,344,944 54,279,608	
		478,615,519		55,009,033		
1881	478,615,519 50,702,669		55,009,033 1,270,200		533,624,552 51,972,869	
		529,318,188		56,279,233		
1882	529,318,188 28,845,830		56,279,233 994,201		585,597,421 29,840,031	
		558,164,018		57,273,434		
1883	558,1[illegible]4,018 27,756,082		57,273,434 980,798		615,437,452 28,736,880	
		585,920,100		58,254,232		644,1
Total	585,920,100		58,254,232		644,174,332	

Progress of Production of Cereals in Thirty Years.



EFFECT OF VARYING PRODUCT ON PRICE OF CORN.

Diagram XIX illustrates the inter-relations of yield and price. The yield per acre is that of the entire breadth of the corn crop, and the price the average for the entire product of the country in farm markets, as reported by counties in December of each year. The reduction of yield in 1873 and 1874 is attended with marked advance in value; and the successive crops above the average in yield cause a continuous decline to a very low figure. The annual yields and prices are as follows:

Years.	Average yield.	Price.
	Bushels.	*Cents.*
1871	29.1	48.2
1872	30.7	39.8
1873	23.8	48.0
1874	20.7	64.7
1875	29.4	42.0
1876	26.1	37.0
1877	26.6	35.8
1878	26.9	31.8
1879	29.2	37.5
1880	27.6	39.6
1881	18.6	63.6
1882	24.6	48.4
1883	22.7	42.4

PRODUCTION OF CEREALS IN THIRTY YEARS.

I[illegible]ram XX illustrates the progress of production of the several cer[illegible]s from 1849 to 1879, as reported in four decennal enumerations. T[illegible] increase has been greater in wheat than in corn, or 357 per cent.; [illegible] corn, 196 per cent.; oats, 178 per cent.; rye, 75 per cent.; barley, 40 [illegible] cent.; buckwheat, 32 per cent.

The prominence of maize is seen in the fact that its production is usually twice as much as the combined product of wheat, oats, rye, barley, and buckwheat. The proportion of each crop to the whole is thus presented:

Cereals.	1850.	1860.	1870.	1880.
Corn	68.3	67.7	54.9	65.1
Wheat	11.6	14.0	20.7	17.0
Oats	16.9	13.9	20.3	15.1
Rye	.6	1.3	2.2	1.6
Barley	1.6	1.7	1.2	.7
Buckwheat	1.0	1.4	.7	.5

The quantity in bushels is shown in the following table:

Cereals.	1850.	1860.	1870.	1880.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels,*
[illegible]	592, 071, 104	838, 792, 742	760, 944, 549	1, 754, 591, 676
[illegible]at	100, 485, 944	173, 104, 924	287, 745, 626	459, 483, 137
[illegible]	146, 584, 179	172, 643, 185	282, 107, 157	407, 858, 999
[illegible]y	14, 188, 813	21, 101, 380	16, 918, 795	19, 831, 595
[illegible]	5, 167, 015	15, 825, 898	29, 761, 305	43, 997, 495
[illegible]kwheat	8, 956, 912	17, 571, 818	9, 821, 721	11, 817, 327
Total	867, 453, 967	1, 239, 039, 947	1, 387, 299, 153	2, 697, 580, 229

PRODUCTION AND EXPORT OF CORN AND WHEAT.

The object of Diagram XXI is to present to the eye a comparative view of the recent production and exportation of corn and wheat, to illustrate the preponderating volume of the one and large proportion exported of the other. The period is seven years of plenty, in which the average estimated product of corn is 1,510,000,000 bushels, and of wheat 436,000,000. There was exported in this period an average of 72,000,000, while of wheat the exports averaged 141,000,000. This left for consumption an average of 1,438,000,000 of corn and 295,000,000 of wheat. This gave, for bread and seed, nearly 6 bushels of wheat per *capita*. The figures are as follows:

Years.	Corn.		Wheat.	
	Product.	Export.	Product.	Export.
1877	1,342,558,000	87,192,110	364,194,146	90,1[illegible]
1878	1,388,218,750	87,884,892	420,122,400	147[illegible]
1879	1,547,901,790	99,572,329	448,756,630	180[illegible]
1880	1,717,434,543	93,648,147	498,549,868	186,[illegible]
1881	1,194,916,000	44,340,683	380,280,090	121[illegible]
1882	1,617,025,100	41,655,658	504,185,470	147[illegible]
1883	1,551,066,895	46,258,606	421,086,160	111,[illegible]

PRODUCT AND EXPORT OF CEREALS.

Diagram XXII compares the production of cereals in 1879 with exportation from that crop between July 1, 1879, and June 30, [illegible] The squares which represent the quantities produced of the se[illegible] grains are drawn to a scale of 3,000,000 bushels per square The design is to present to the eye at a single glance an idea o[illegible] respective volumes of the different crops and the proportions of exported. Every one who knows the facts is aware of the gr[illegible] ponderance of the corn crop; but there are few to whom the ex[illegible] portion, presented so clearly to the natural eye, does not prove a [illegible] elation to the mental vision. It is seen that the maize makes a lar[illegible] show than the other five combined, and that the three minor c[illegible] barley, rye, and buckwheat, taken together, only make 3 per cent. of all. The proportions are thus shown in figures:

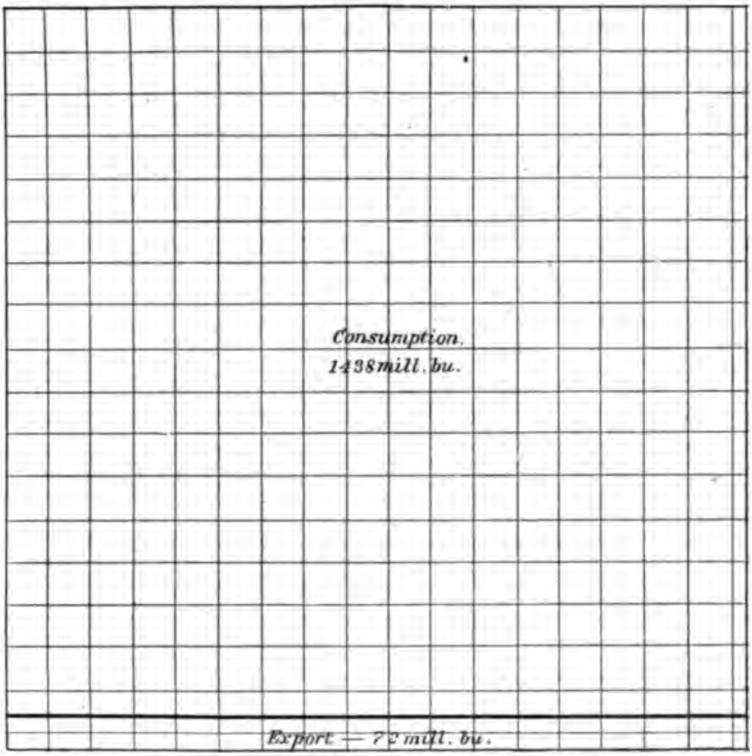
Cereals.	Product.	Export.
	Bushels.	*Bushels.*
Corn	1,754,591,676	99,572,329
Wheat	459,483,137	180,304,180
Oats	407,858,999	766,366
Barley	43,997,495	1,128,923
Rye	19,831,595	2,936,180
Buckwheat	11,817,327	....

PRODUCT PER HEAD OF ALL CEREALS.

The design of Diagram XXIII is to show the comparative production of cereals in Europe and in the United States. The latest available statistics of annual production are used. The European average is 16.1 bushels per head; that of the United States more than three

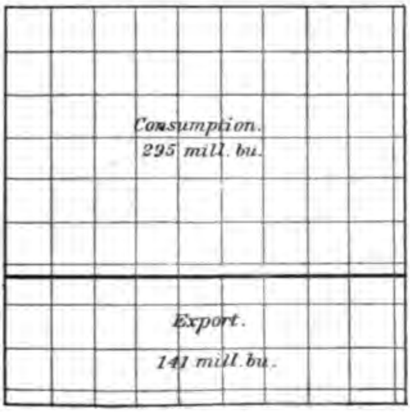
Product and Export of Corn and Wheat.

Average of Seven Years, (1877-1883,) 1510 millions bushels.



Wheat.

Average of Seven Years, (1877-1883,) 436 millions bushels.



Scale:—5 mill. bu. per Square.

Product and Export of Cereals in 1879. (Census.)

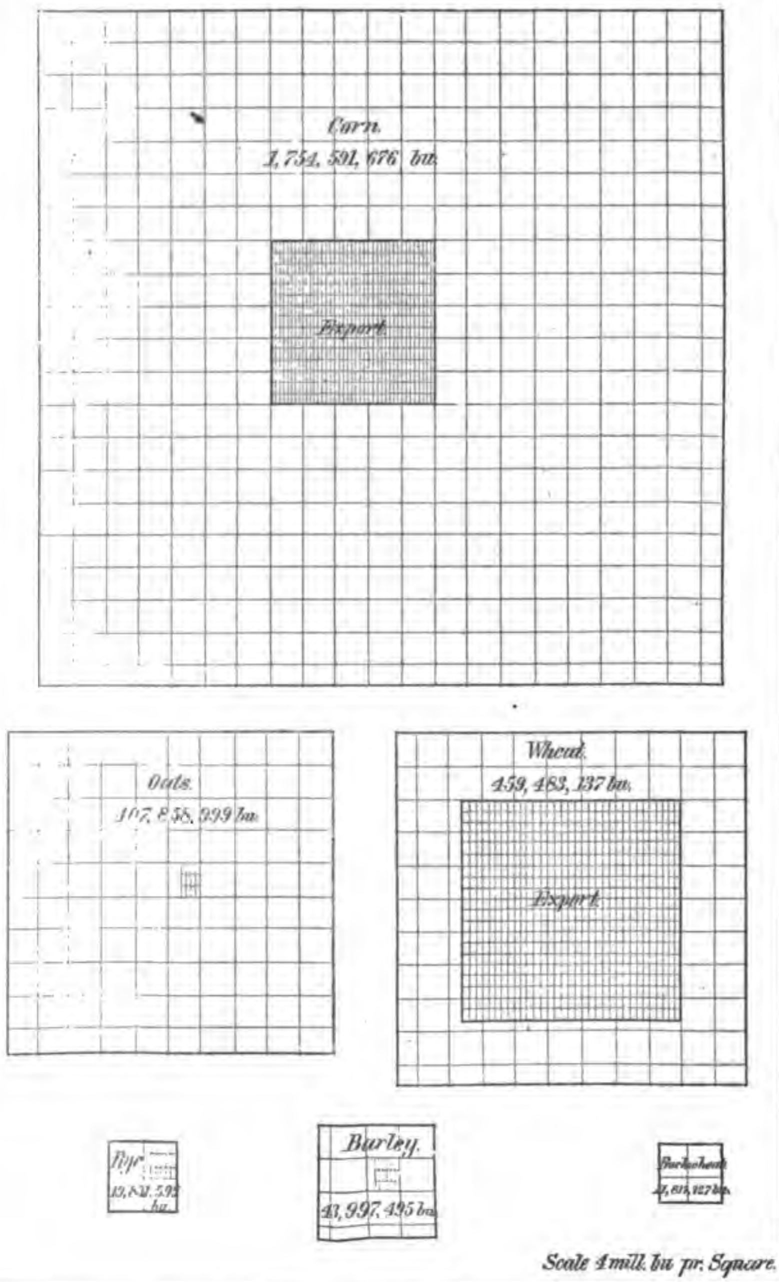
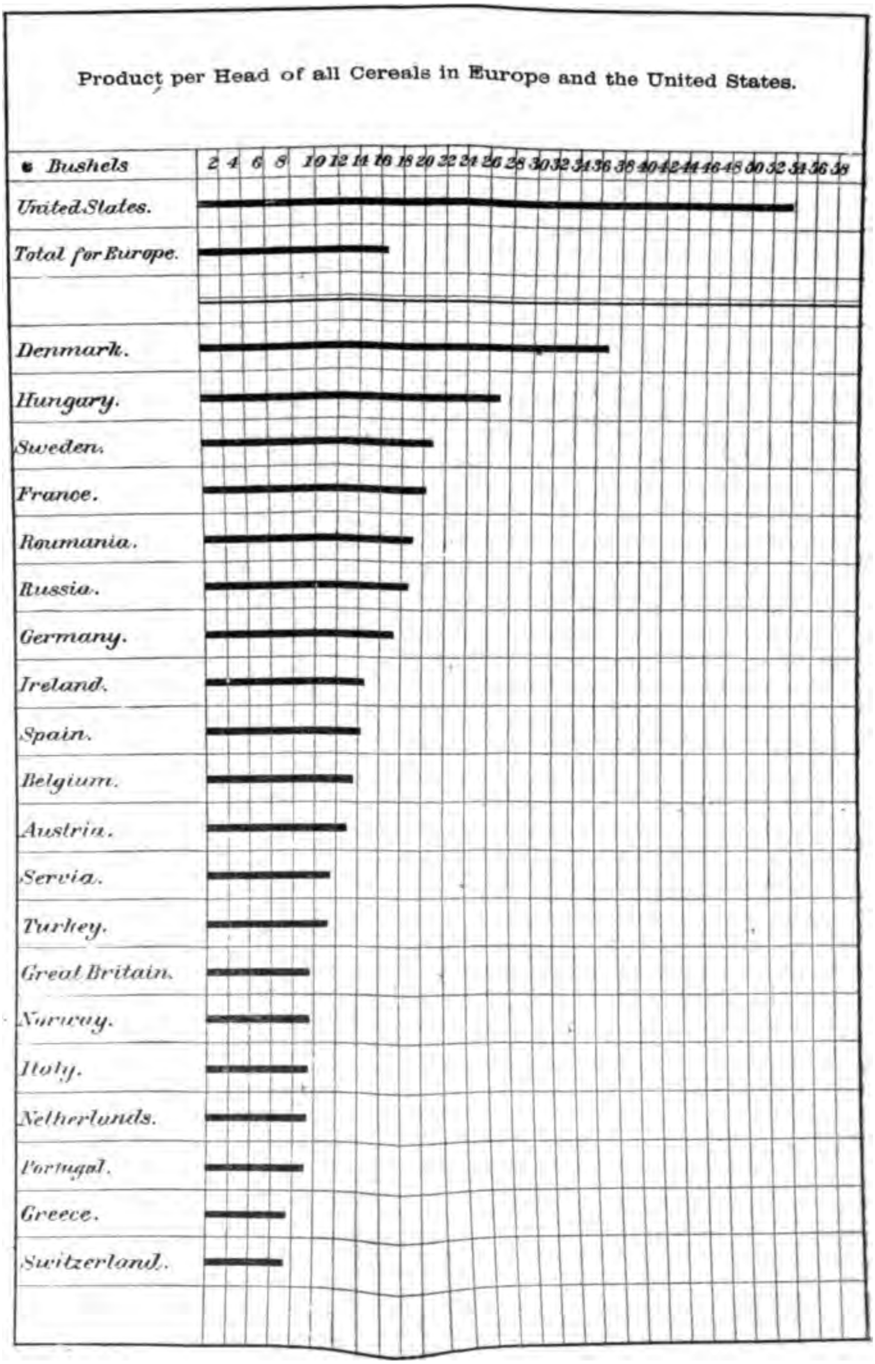
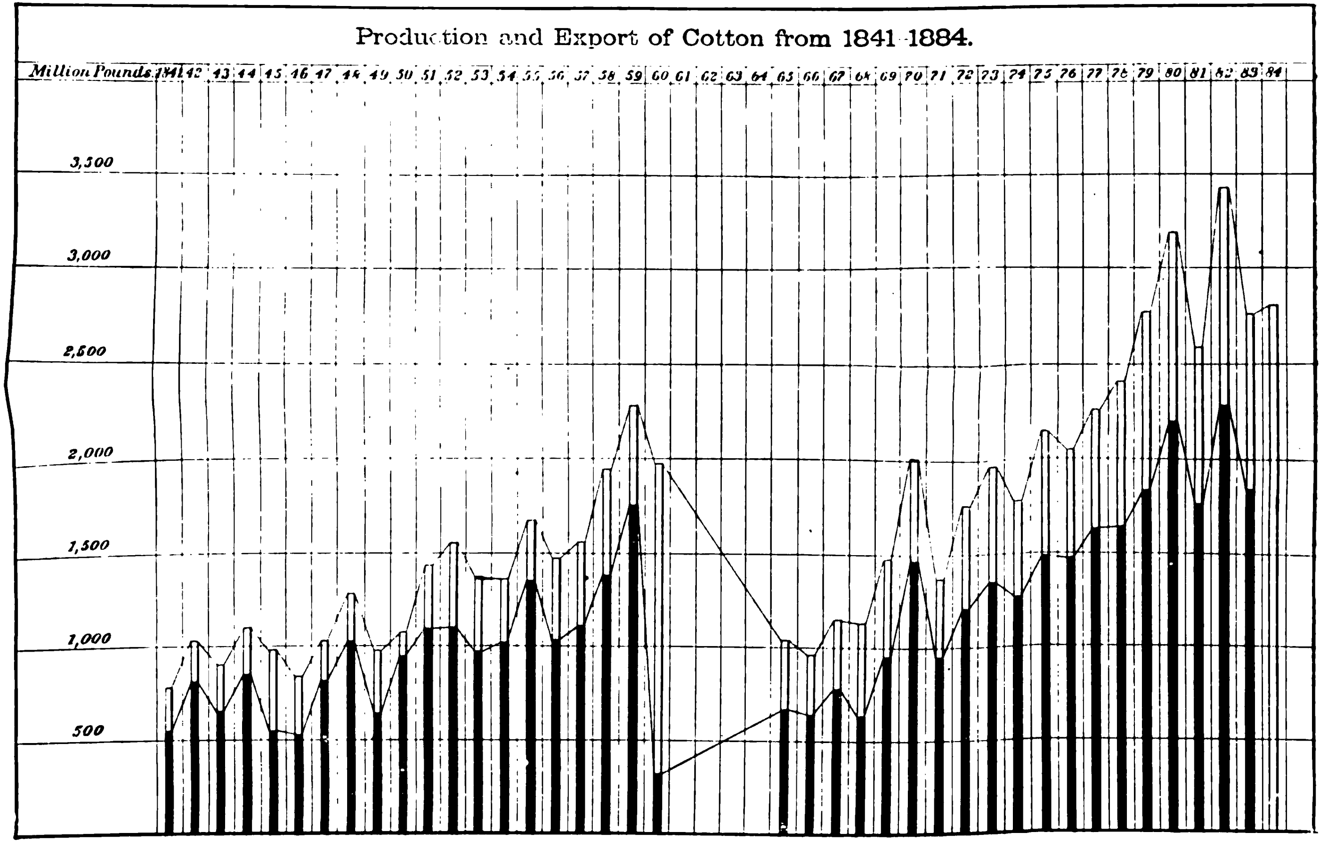


DIAGRAM XXIII.




Production and Export of Cotton from 1841-1884.
Million Pounds
1841 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84
3,500
3,000
2,500
2,000
1,500
1,000
500

times as much, or 53.8 bushels. France, Germany, Hungary, Roumania, Denmark, and Sweden exceed the European average, other count following below it; Switzerland producing only 6.5 bushels per . The use of corn in this country in place of roots and forage ts in feeding of farm animals makes the actual disparity of Europ averages less than it appears. This substitution of one crop for ier renders difficult a discriminating comparison of relative abunce. Making any reasonable allowance on this score, the fact remains un ecedented supply in the United States for the sustenance of man 1 ast. The following table gives the quantities and average per :

Product per head of all cereals.

Countries.	Total bushels.	Bushels per head.	Countries.	Total bushels.	Bushels per head.
1 States	2,697,580,229	53.8	Belgium	74,655,797	13.4
s	5,273,398,496	16.1	Austria	290,453,674	13.0
			Servia	14,303,520	11.4
ark	74,456,840	36.9	Turkey	110,341,440	11.3
y	426,062,544	27.2	Great Britain	286,246,289	9.5
[illegible]	98,262,908	21.5	Norway	16,915,642	9.3
[illegible]	763,754,669	20.3	Italy	262,659,795	9.2
[illegible]	102,850,000	19.1	Netherlands	37,029,985	8.9
[illegible]	1,567,831,233	18.8	Portugal	34,771,906	8.7
ny	784,147,845	17.3	Greece	10,525,854	6.7
[illegible]	74,482,114	14.6	Switzerland	17,473,296	6.5
[illegible]	226,173,145	14.1			

PROGRESS OF COTTON PRODUCTION.

Diagram XXIV illustrates the progress of cotton-growing since 1840. A period of twenty years from 1841 to 1860, inclusive, is compared with the twenty years since the civil war, from 1865 to 1884, inclusive. One covers two decades of production under the system of involuntary servitude; the other, production by free labor. It shows a rapid and almost continuous progress in each period, in response to the constantly increasing wants of the civilized world. It shows that no labor convulsion, no social upheaval, no sudden impoverishment of individuals can subvert the manifest destiny of the cotton belt of North America to supply the world with the cotton fiber.

The dark perpendicular bands in the diagram represent the cotton retained for home consumption, while the lighter extensions show the proportion of each year exported. The height of the two indicates the total amount of the crop in pounds, according to the scale, so far as the crop of each year is represented by the annual records of the cotton movement.

It is an exhibit which speaks well for the soil of the cotton region, the recuperative powers of the great industry so prostrated, and is in itself a grand prophecy of progress in the future.

Years.	Production.	Exports.
	Pounds.	*Pounds.*
1841	759,903,750	584,717,017
1842	1,077,391,350	792,297,106
1843	948,860,550	663,633,455
1844	1,118,097,900	872,905,996
1845	976,741,650	547,558,055
1846	837,215,550	527,219,958
1847	1,090,850,850	814,274,431
1848	1,263,868,200	1,026,602,269

Years.	Production.	Exports.
	Pounds.	*Pounds.*
1849	977,267,700	[illegible]
1850	1,086,865,650	[illegible]
1851	1,421,413,340	1,[illegible]
1852	1,542,325,720	1,[illegible]
1853	1,396,112,420	987,8[illegible]
1854	1,363,537,635	1,008,42[illegible]
1855	1,658,631,975	1,351,43[illegible]
1856	1,467,129,120	1,048,28[illegible]
1857	1,554,701,760	1,118[illegible]
1858	1,949,306,728	1,386[illegible]
1859	2,274,372,309	1,767,[illegible]
1860	1,934,545,603	307,6[illegible]
Total	26,699,139,760	18,573,01[illegible]
1861–1864	....	....
1865	1,041,962,263	[illegible]
1866	969,175,303	[illegible]
1867	1,173,431,114	[illegible]
1868	1,129,811,645	[illegible]
1869	1,451,401,357	[illegible]
1870	2,020,693,736	1,[illegible]
1871	1,384,084,494	[illegible]
1872	1,833,188,931	1[illegible]
1873	1,940,648,352	1[illegible]
1874	1,783,644,032	1[illegible]
1875	2,157,958,142	1[illegible]
1876	2,082,492,190	1,[illegible]
1877	2,260,285,666	1[illegible]
1878	2,404,410,373	1[illegible]
1879	2,771,797,156	1,[illegible]
1880	3,199,822,682	2,192,[illegible]
1881	2,588,736,636	1,741,81[illegible]
1882	3,405,070,410	2,291,31[illegible]
1883	2,757,544,422	1,862,57[illegible]
1884	2,800,000,000	....
Total	41,156,158,904	26,026,36[illegible]

The product of the first period was 26,699,139,760 pounds, equal to 53,398,279 bales of 500 pounds gross weight (including baling, as all cotton is sold in this country). It is an annual average for the period of 2,669,914 bales of this size. The more recent period of twenty years, if we allow 2,800,000,000 pounds gross for the crop of 1884, furnishes a product of 41,156,158,904 pounds, or 82,312,317 bales of the same weight. This makes an annual average of 4,115,616 bales, and an increased production of 54.1 per cent. over the first period.

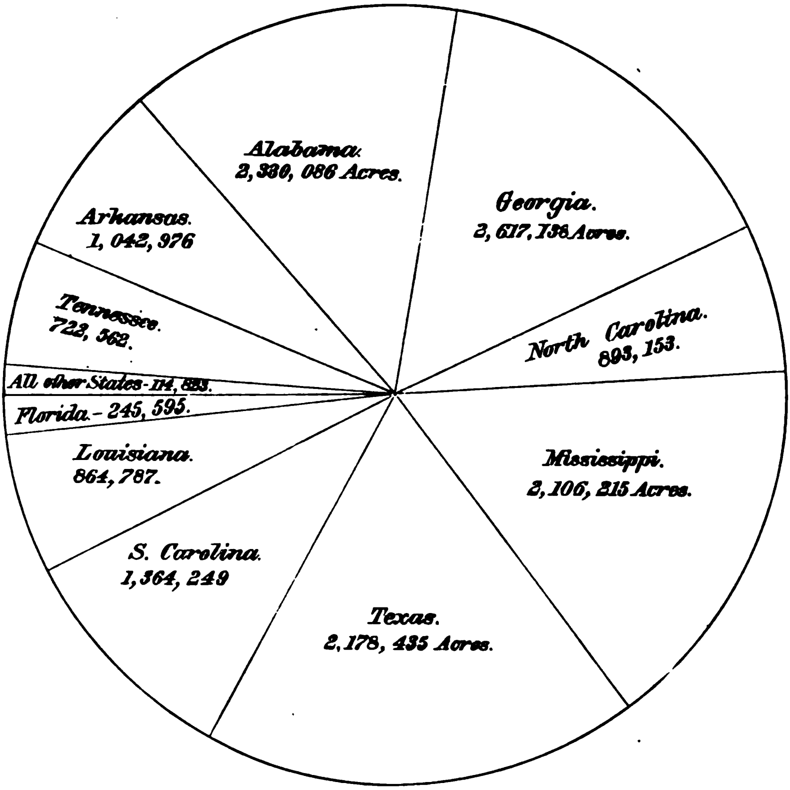
A still more interesting and important fact is the increased home consumption. Of the first twenty years' product there remained, after exportation, 30.5 per cent. of the whole; while of the product of the recent period there remained 36.8 per cent. The actual quantities were, respectively, 8,126,126,734 and 15,129,792,522. The quantity actually manufactured is therefore nearly twice as much as in the twenty years before 1860.

AREA OF COTTON.

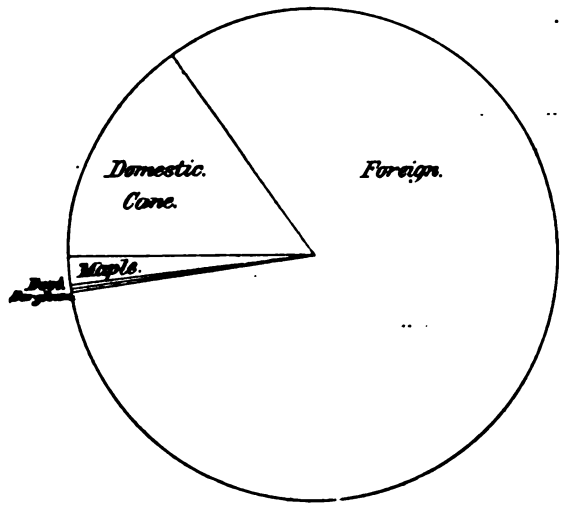
The area of cotton has increased rapidly in the past twenty years, with somewhat unequal annual steps, and with very little halting. The area attained in 1884 has exceeded 17,000,000 acres, constituting about one-third of the cultivated area of the cotton States, corn and cotton comprising fully three-fourths of the entire acreage in arable culture.

The idea of Diagram XXV is to present the area by States, as reported for the year 1879 by the census. Many may feel a greater confidence in the census returns than in any estimates, though my own estimate for that year was 14,500,000 acres, while the census made it

Acreage of Cotton, 1879. (Census.)



Sugar Consumption and Production in the United States.

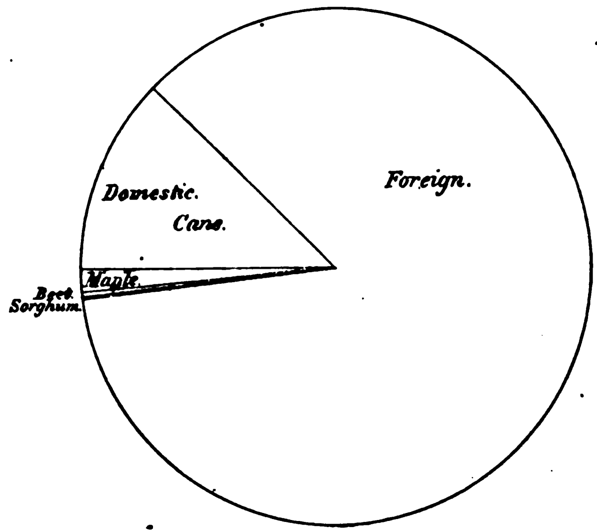


1882.

Consumption 1,079,949 tons.

Production 176,285 tons.

Cane, 155,533 tons.
Maple, 20,000 "
Beets, 500 "
Sorghum, 250 "



1883.

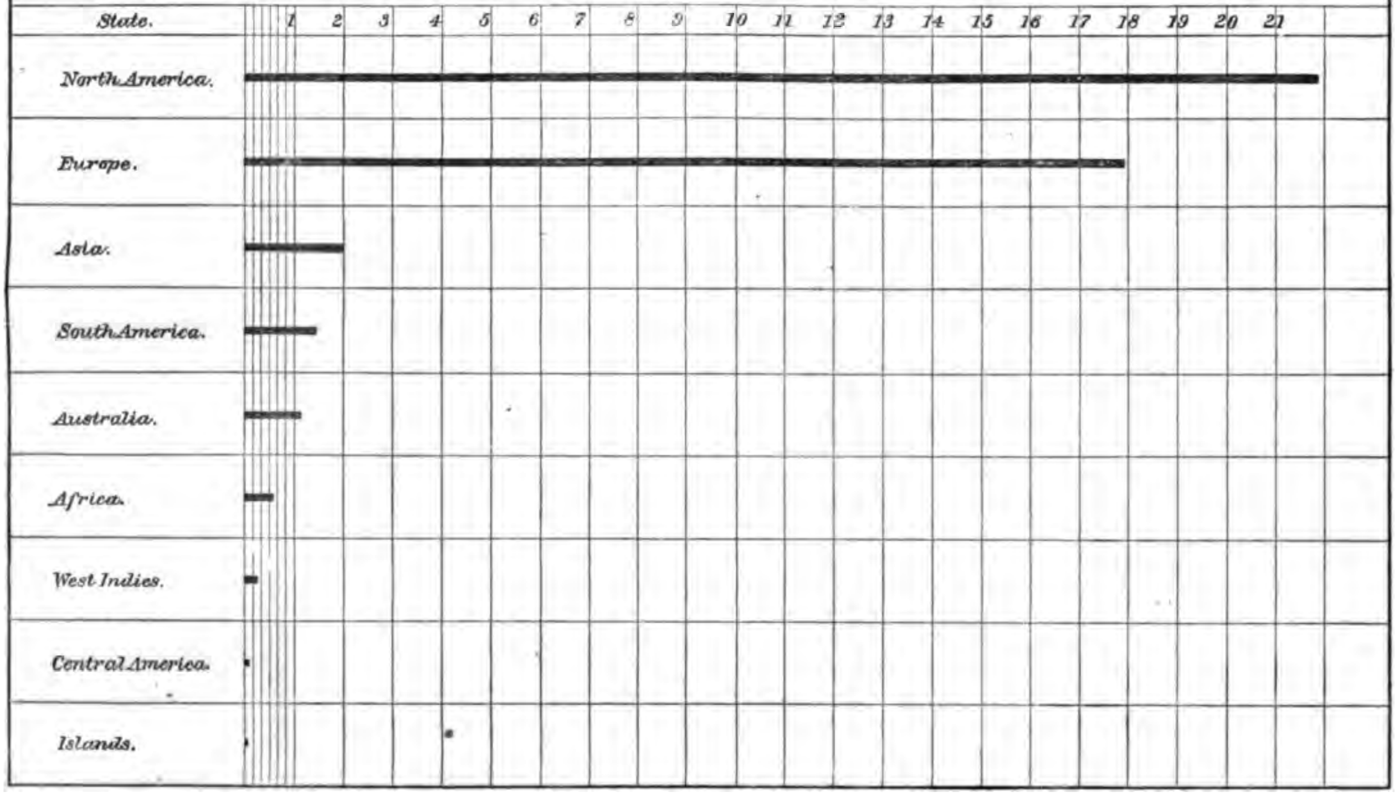
Consumption 1,164,391 tons.

Production 166,855 tons.

Cane, 147,355 tons.
Maple, 18,000 "
Beets, 600 "
Sorghum, 400 "

DIAGRAM XXVII.

Comparative Railway Facilities of the World.



14,480,019 acres. The diagram is in the form of a circle whose area represents the breadth in cotton, the proportions of the several States being shown respectively as segments of such circle, of differing degrees, according to the following statement:

	Acres.
Georgia	2,617,138
Alabama	2,330,086
Texas	2,178,435
Mississippi	2,106,215
South Carolina	1,364,249
Arkansas	1,042,976
North Carolina	893,153
Louisiana	864,787
Tennessee	722,562
Florida	245,595
All others	114,823
Total	14,480,019

SUGAR CONSUMPTION AND PRODUCTION.

Diagram XXVI represents the consumption of sugar in the United States in 1882 and 1883, by circles, which are divided to show the proportion of foreign and domestic product, while the segment which stands for domestic sugar is subdivided to show the quantity of maple, beet, and sorghum, as well as cane. Scarcely more than a line suffices to indicate the almost inappreciable quantities of beet and sorghum.

The statement, in tons, is as follows:

Description.	Production.		Production.	
	Tons.	Per cent.	Tons.	Per cent.
Louisiana cane	151,533	14.0	143,855	12.3
Others	4,000	.4	3,500	.3
Maple	20,000	1.9	18,500	1.6
Beet	500	....	600	.1
Sorghum	250	....	400	....
Total	176,283	16.3	166,855	14.3

	Tons.
Consumption in 1882	1,079,949
Consumption in 1883	1,164,391

RAILWAY FACILITIES OF THE WORLD.

On the authority of the "Railways of the World," by Mr. D. McArthur, Diagram XXVII is constructed to show, by a simple lineal comparison, the relative mileage of railways in North America and other grand divisions of the globe. The statement is as follows:

	Miles.
North America	126,852
Europe	107,983
Asia	11,923
South America	8,680
Australia	6,938
Africa	3,353
West Indies	1,513
Central America	398
Islands	209

FARM VALUES.

Diagram XXVIII makes comparison of farm values, by squa different sizes, the superficial area of each showing the relativ portion of value in lands, farm animals, and farm implements. ures used are those of four decennial census enumerations. They as follows:

Years.	Lands.	Animals.	Implem
1850	3, 271, 575, 426	544, 180, 516	
1860	6, 645, 045, 007	1, 089, 329, 915	
1870	9, 262, 803, 861	1, 525, 276, 457	
1880	10, 197, 096, 776	1, 500, 384, 707	

FARM AND FOREST AREAS.

Diagram XXIX represents, in square figures, the superfi areas of the several States and Territories, with interior squa show the farm areas, divided to show the woodland. It indi glance the comparative amount of land not taken as farms. Un the least, and some of the Territories are mostly unoccupied, the making a scarcely appreciable exhibit. The figures are as follow

States and Territories.	Superficial area.	Acres in farms.	Acres in woo land.
Alabama	32, 985, 600	18, 855, 334	10,
Arizona	72, 268, 800	135, 578	
Arkansas	33, 948, 800	12, 061, 547	7,
California	99, 827, 200	16, 593 742	1,
Colorado	66, 332, 800	1, 165, 378	
Connecticut	3, 100, 800	2, 453, 541	
Dakota	94, 528, 000	3, 800, 656	
Delaware	1, 254, 400	1, 090, 245	
District of Columbia	38, 400	18, 146	
Florida	34, 713, 600	3, 297, 324	2
Georgia	37, 747, 200	26, 043, 282	15
Idaho	53, 945, 600	327, 798	
Illinois	35, 840, 000	31, 673, 645	4
Indiana	22, 982, 400	20, 420, 983	5
Iowa	35, 504, 000	24, 752, 700	2
Kansas	52, 288, 000	21, 417, 468	
Kentucky	25, 600, 000	21, 495, 240	10,
Louisiana	29, 068, 800	8, 273, 506	4
Maine	19, 132, 800	6, 552, 578	2
Maryland	6, 310, 400	5, 119, 831	1,
Massachusetts	5, 145, 600	3, 359, 079	1,
Michigan	36, 755, 200	13, 807, 240	4,
Minnesota	50, 691, 200	13, 403, 019	2,
Mississippi	29, 657, 600	15, 855, 462	9,
Missouri	43, 990, 400	27, 879, 276	10,
Montana	92, 998, 400	405, 683	
Nebraska	48, 758, 400	9, 944, 826	
Nevada	70, 233, 600	530, 862	
New Hampshire	5, 763, 200	3, 721, 173	1
New Jersey	4, 771, 200	2, 929, 773	
New Mexico	78, 374, 400	631, 131	
New York	30, 476, 800	23, 780, 754	5,
North Carolina	31, 091, 200	22, 363, 558	13,
Ohio	26, 086, 400	24, 529, 226	5,
Oregon	60, 518, 400	4, 214, 712	1,
Pennsylvania	28, 790, 400	19, 791, 341	5,
Rhode Island	694, 400	514, 813	
South Carolina	19, 308, 800	13, 457, 613	7
Tennessee	26, 720, 000	20, 666, 915	11
Texas	167, 865, 600	36, 292, 219	15
Utah	52, 601, 600	655, 520	
Vermont	5, 846, 400	4, 882, 588	1,
Virginia	25, 680, 000	19, 835, 785	9,
Washington	42, 803, 200	1, 409, 421	
West Virginia	15, 772, 800	10, 193, 779	
Wisconsin	34, 848, 000	15, 353, 118	
Wyoming	62, 448, 000	124, 433	—
United States	1, 856, 108, 800	536, 081, 835	

FOREST LANDS IN FARMS.

Diagram XXX is in the form of a map of the United States, colored by counties, in five shades to show as many degrees of density of forest lands in farms. The proportion of woodland area in the farm lands reported by the last census is thus expressed:

ALABAMA.

Counties.	Per cent.	Counties.	Per cent.	Counties.	Per cent.
Antauga	62	Dallas	35	Marshall	64
Baldwin	91	De Kalb	66	Mobile	72
Barbour	41	Elmore	57	Monroe	62
Bibb	54	Escambia	90	Montgomery	27
Blount	69	Etowah	66	Morgan	59
Bullock	30	Fayette	78	Perry	32
Butler	54	Franklin	73	Pickens	61
Calhoun	56	Geneva	80	Pike	53
Chambers	32	Greene	40	Randolph	66
Cherokee	60	Hale	39	Russell	29
Chilton	72	Henry	57	Saint Clair	69
Choctaw	68	Jackson	64	Shelby	67
Clarke	71	Jefferson	69	Sumter	42
Clay	71	Lamar	77	Talladega	54
Cleburne	72	Landerdale	58	Tallapoosa	47
Coffee	63	Lawrence	46	Tuscaloosa	64
Colbert	60	Lee	35	Walker	81
Conecuh	61	Limestone	48	Washington	78
Coosa	66	Lowndes	24	Wilcox	50
Covington	71	Macon	37	Winston	85
Crenshaw	59	Madison	37		
Cullman	80	Marengo	49	Total	55
Dale	55	Marion	81		

ARIZONA TERRITORY.

Apache	7	Pima	2	Yuma	9
Maricopa	1	Pinal	7		
Mohave	21	Yavapai	22	Total	10

ARKANSAS.

Arkansas	62	Greene	66	Phillips	48
Ashley	71	Hempstead	63	Pike	76
Baxter	72	Hot Spring	71	Poinsett	77
Benton	54	Howard	64	Polk	65
Boone	56	Independence	66	Pope	59
Bradley	76	Izard	73	Prairie	65
Calhoun	75	Jackson	69	Pulaski	53
Carroll	50	Jefferson	57	Randolph	67
Chicot	63	Johnson	62	Saint Francis	65
Clark	63	La Fayette	63	Saline	70
Clay	68	Lawrence	66	Scott	75
Columbia	68	Lee	65	Searcy	48
Conway	61	Lincoln	77	Sebastian	56
Craighead	67	Little River	73	Sevier	72
Crawford	57	Logan	63	Sharp	72
Crittenden	54	Lonoke	63	Stone	69
Cross	68	Madison	54	Union	68
Dallas	76	Marion	45	Van Buren	72
Desha	66	Miller	66	Washington	53
Dorsey	77	Mississippi	66	White	69
Drew	76	Monroe	69	Woodruff	55
Faulkner	74	Montgomery	49	Yell	70
Franklin	58	Nevada	63		
Fulton	33	Newton	57	Total	65
Garland	80	Ouachita	60		
Grant	81	Perry	76		

CALIFORNIA.

Counties.	Per cent.	Counties.	Per cent.	Counties.	Per cent.
Alameda	2	Mendocino	29	Santa Clara	[illegible]
Alpine	15	Merced	1	Santa Cruz	[illegible]
Amador	24	Modoc	4	Shasta	[illegible]
Butte	8	Mono	1	Sierra	[illegible]
Calaveras	22	Monterey	4	Siskiyou	[illegible]
Colusa	7	Napa	31	Solano	[illegible]
Contra Costa	2	Nevada	46	Sonoma	[illegible]
Del Norte	25	Placer	21	Stanislaus	[illegible]
El Dorado	39	Plumas	15	Sutter	[illegible]
Fresno	4	Sacramento	3	Tebama	[illegible]
Humboldt	22	San Benito	3	Trinity	[illegible]
Inyo	......	San Bernardino	2	Tulare	[illegible]
Kern	39	San Diego	1	Tuolumne	[illegible]
Lake	45	San Francisco	......	Ventura	[illegible]
Lassen	5	San Joaquin	5	Yola	[illegible]
Los Angeles	1	San Luis Obispo	11	Yuba	[illegible]
Marin	7	San Mateo	12		
Mariposa	40	Santa Barbara	5	Total	[illegible]

COLORADO.

Arapahoe	1	Fremont	......	Ouray	[illegible]
Bent	8	Gilpin	30	Park	[illegible]
Boulder	......	Grand	......	Pueblo	[illegible]
C. affee	4	Gunnison	1	Rio Grande	[illegible]
Clear Creek	66	Hinsdale	30	Routt	......
Conejos	2	Huerfano	5	Saguache	......
Costilla	2	Jefferson	7	San Juan	......
Custer	3	Lake	9	Summit	......
Douglas	3	La Plata	......	Weld	[illegible]
Elbert	1	Larimer	2		
El Paso	4	Las Animas	......	Total	[illegible]

CONNECTICUT.

Fairfield	21	New Haven	26	Windham	[illegible]
Hartford	25	New London	27		
Litchfield	25	Tolland	29	Total	[illegible]
Middlesex	33				

DAKOTA TERRITORY.

Aurora	26	Grand Forks	7	Potter	11
Barnes	5	Grant	1	Pratt	......
Beadle	......	Gregory	......	Presho	......
Billings	......	Hamlin	......	Ramsey	[illegible]
Bon Homme	1	Hand	......	Ransom	[illegible]
Boreman	69	Hanson	2	Renville	......
Bottineau	......	Howard	......	Richland	[illegible]
Brookings	......	Hughes	20	Rolette	......
Brown	3	Hutchinson	......	Rusn	......
Brule	1	Hyde	......	Shannon	[illegible]
Buffalo	......	Kidder	......	Sheridan	......
Burleigh	6	Kingsbury	......	Spink	[illegible]
Campbell	63	Lake	......	Stanley	......
Cass	1	La Moure	......	Stark	......
Cavilier	......	Lawrence	3	Stevens	......
Charles Mix	23	Lincoln	1	Stutsman	......
Cheyenne	......	Logan	......	Sully	......
Clark	......	Lugenbeel	......	Todd	......
Clay	3	Lyman	......	Traill	4
Codington	1	McCook	......	Tripp	......
Custer	1	McHenry	......	Turner	1
Davison	......	McPherson	......	Union	4
Day	36	Mandan	......	Wallette	......
Delano	......	Mercer	......	Walworth	[illegible]
De Smet	......	Meyer	......	White River	......
Deuel	1	Miner	1	Williams	......
Douglas	......	Minnehaha	1	Yankton	1
Edmunds	......	Moody	......	Ziebach	......
Emmons	3	Morton	......	Sisseton and Wahpeton Indian Reservation	......
Faulk	......	Mountraille	......		
Forsyth	......	Pembina	9		
Foster	14	Pennington	......	Total	[illegible]
Gingras	......				

DELAWARE.

Counties.	Per cent.	Counties.	Per cent.	Counties.	Per cent.
....	22	New Castle	10	Sussex	36
		....	......	Total	26

DISTRICT OF COLUMBIA.

the District of Columbia	18

FLORIDA.

....	62	Hillsborough..............	81	Polk	56
....	96	Holmes	50	Putnam	77
....	65	Jackson..................	57	Saint John's..............	84
....	90	Jefferson................	87	Santa Rosa	79
....	78	La Fayette...............	67	Sumter....................	76
....	82	Leon	31	Suwannee	65
....	69	Levy	66	Taylor	71
....	......	Liberty	91	Volusia	83
....	87	Madison	52	Wakulla	79
....	84	Manatee	65	Walton	62
....	67	Marion....................	68	Washington..............	52
....	59	Monroe...................	62		
....	69	Nassau...................	89	Total..............	66
o	78	Orange...................	85		

GEORGIA.

....	96	Floyd	57	Oconee	26
....	40	Forsyth	46	Oglethorpe	26
....	40	Franklin	55	Paulding	59
....	68	Fulton	51	Pickens	74
....	56	Gilmer	80	Pierce......................	88
....	91	Glascock	48	Pike	37
....	45	Glynn......................	88	Polk	53
....	70	Gordon....................	61	Pulaski	55
....	92	Greene	32	Putnam	36
....	91	Gwinnett	53	Quitman	39
....	43	Habersham...............	81	Raeun	89
....	37	Hall	66	Randolph	43
....	54	Hancock	32	Richmond.................	62
....	90	Haralson	77	Rockdale..................	32
....	46	Harris.....................	47	Schley	31
....	61	Har	52	Screven	70
....	58	Heard.....................	50	Spalding	40
....	95	Henry.....................	40	Stewart	31
....	62	Houston..................	39	Sumter	47
ochee	41	Irwin	94	Talbot	34
a....................	62	Jackson	47	Taliaferro.................	36
....	63	Jasper	27	Tattnall	94
....	44	Jefferson	85	Taylor	53
....	50	Johnson...................	72	Telfair	82
....	42	Jones	25	Terrell	54
....	92	Laurens...................	67	Thomas....................	68
....	42	Lee	41	Towns	73
....	91	Liberty	81	Troup......................	25
....	91	Lincoln	18	Twiggs....................	30
....	27	Lowndes	79	Union	74
....	33	Lumpkin..................	75	Upson.....................	36
....	37	McDuffie..................	39	Walker	61
....	68	McIntosh	79	Walton	44
....	66	Macon	45	Ware	92
....	72	Madison...................	48	Warren	82
....	48	Marion....................	49	Washington..............	47
....	87	Meriwether	35	Wayne.....................	96
....	57	Miller	71	Webster	40
ty	40	Milton	46	White	77
....	65	Mitchell...................	56	Whitfield	62
....	60	Monroe...................	38	Wilcox....................	89
....	85	Montgomery	90	Wilkes.....................	23
n'	84	Morgan	37	Wilkinson..................	39
....	34	Murray	67	Worth	76
....	89	Muscogee	33		
....	81	Newton	34	Total..............	59
....	46				

IDAHO TERRITORY.

Counties.	Per cent.	Counties.	Per cent.	Counties.	Per cent.
Ada	8	Idaho	3	Owyhee	[illegible]
Alturas	20	Kootenai	27	Shoshone	[illegible]
Bear Lake	......	Lemhi	3	Washington	[illegible]
Boise	8	Nez Perces	......		
Cassia	......	Oneida	1	Total	[illegible]

ILLINOIS.

Counties.	Per cent.	Counties.	Per cent.	Counties.	Per cent.
Adams	20	Henderson	14	Ogle	[illegible]
Alexander	51	Henry	4	Peoria	[illegible]
Bond	14	Iroquois	4	Perry	[illegible]
Boone	13	Jackson	36	Piatt	[illegible]
Brown	31	Jasper	29	Pike	[illegible]
Bureau	8	Jefferson	33	Pope	[illegible]
Calhoun	58	Jersey	26	Pulaski	[illegible]
Carroll	9	Jo Daviess	29	Putnam	[illegible]
Cass	28	Johnson	46	Randolph	[illegible]
Champaign	2	Kane	11	Richland	[illegible]
Christian	6	Kankakee	2	Rock Island	[illegible]
Clark	31	Kendall	5	Saint Clair	[illegible]
Clay	23	Knox	10	Saline	[illegible]
Clinton	16	Lake	16	Sangamon	[illegible]
Coles	11	La Salle	7	Schuyler	[illegible]
Cook	5	Lawrence	27	Scott	[illegible]
Crawford	29	Lee	3	Shelby	[illegible]
Cumberland	19	Livingston	2	Stark	[illegible]
De Kalb	4	Logan	6	Stephenson	[illegible]
De Witt	9	McDonough	13	Tazewell	[illegible]
Douglas	6	McHenry	12	Union	[illegible]
Du Page	7	McLean	5	Vermillion	[illegible]
Edgar	10	Macon	5	Wabash	[illegible]
Edwards	32	Macoupin	17	Warren	[illegible]
Effingham	24	Madison	11	Washington	[illegible]
Fayette	28	Marion	25	Wayne	[illegible]
Ford	1	Marshall	12	White	[illegible]
Franklin	34	Mason	11	Whiteside	[illegible]
Fulton	28	Massac	45	Will	[illegible]
Gallatin	38	Menard	13	Williamson	[illegible]
Greene	23	Mercer	11	Winnebago	[illegible]
Grundy	4	Monroe	34	Woodford	[illegible]
Hamilton	33	Montgomery	12		
Hancock	17	Morgan	17	Total	[illegible]
Hardin	43	Moultrie	10		

INDIANA.

Counties.	Per cent.	Counties.	Per cent.	Counties.	Per cent.
Adams	43	Henry	27	Posey	[illegible]
Allen	35	Howard	31	Pulaski	[illegible]
Bartholomew	29	Huntington	35	Putnam	[illegible]
Benton	3	Jackson	39	Randolph	[illegible]
Blackford	40	Jasper	13	Ripley	[illegible]
Boone	32	Jay	40	Rush	[illegible]
Brown	46	Jefferson	28	Saint Joseph	[illegible]
Carroll	34	Jennings	31	Scott	[illegible]
Cass	32	Johnson	26	Shelby	[illegible]
Clark	31	Knox	27	Spencer	[illegible]
Clay	29	Kosciusko	32	Starke	[illegible]
Clinton	30	Lagrange	25	Steuben	[illegible]
Crawford	50	Lake	18	Sullivan	[illegible]
Daviess	27	La Porte	16	Switzerland	[illegible]
Dearborn	26	Lawrence	32	Tippecanoe	[illegible]
Decatur	28	Madison	33	Tipton	[illegible]
De Kalb	33	Marion	27	Union	[illegible]
Delaware	30	Marshall	29	Vanderburgh	[illegible]
Dubois	47	Martin	41	Vermillion	[illegible]
Elkhart	25	Miami	32	Vigo	[illegible]
Fayette	23	Monroe	39	Wabash	[illegible]
Floyd	35	Montgomery	24	Warren	[illegible]
Fountain	26	Morgan	33	Warrick	[illegible]
Franklin	32	Newton	9	Washington	[illegible]
Fulton	26	Noble	29	Wayne	[illegible]
Gibson	30	Ohio	24	Wells	[illegible]
Grant	33	Orange	38	White	[illegible]
Greene	28	Owen	25	Whitely	[illegible]
Hamilton	31	Parke	29		
Hancock	31	Perry	55	Total	[illegible]
Harrison	38	Pike	28		
Hendricks	26	Porter	16		

IOWA.

Counties.	Per cent.	Counties.	Per cent.	Counties.	Per cent.
	3	Franklin	3	Montgomery	4
	6	Fremont	10	Muscatine	12
ee	34	Greene	5	O'Brien	1
se	22	Grundy	1	Osceola	3
a	3	Guthrie	9	Page	6
	5	Hamilton	5	Palo Alto	5
awk	6	Hancock	2	Plymouth	1
	6	Hardin	8	Pocahontas	2
	10	Harrison	12	Polk	11
n	9	Henry	16	Pottawattamie	6
ista	1	Howard	7	Poweshiek	5
	5	Humboldt	3	Ringgold	10
	3	Ida	1	Sac	2
	2	Iowa	9	Scott	6
	4	Jackson	28	Shelby	3
	10	Jasper	7	Sioux	1
rdo	3	Jefferson	22	Story	6
e	1	Johnson	15	Tama	6
aw	10	Jones	17	Taylor	8
	14	Keokuk	13	Union	7
	4	Kossuth	4	Van Buren	31
	34	Lee	26	Wapello	19
	6	Linn	15	Warren	11
d	2	Louisa	19	Washington	13
	10	Lucas	12	Wayne	9
	27	Lyon	5	Webster	9
	22	Madison	15	Winnebago	8
e	17	Mahaska	13	Winneshiek	15
nes	25	Marion	17	Woodbury	6
n	6	Marshall	5	Worth	5
e	24	Mills	10	Wright	4
	5	Mitchell	7		
	15	Monona	7	Total	11
	7	Monroe	22		

KANSAS.

	4	Greeley	......	Pottawatomie	10
n	8	Greenwood	8	Pratt	......
e	......	Hamilton	......	Rawlins	......
a	16	Harper	......	Reno	1
	9	Harvey	1	Republic	2
	......	Hodgeman	......	Rice	1
	11	Jackson	12	Riley	6
	6	Jefferson	18	Rooks	1
	......	Jewell	2	Rush	......
	4	Johnson	10	Russell	1
	9	Kansas	......	Saline	2
qua	14	Kearney	......	Scott	......
e	6	Kingman	......	Sedgwick	1
e	......	Labette	4	Sequoyah	......
	......	Lane	......	Seward	......
	2	Leavenworth	21	Shawnee	9
	2	Lincoln	2	Sheridan	......
	8	Linn	13	Sherman	......
ie	8	Lyon	8	Smith	2
	4	McPherson	1	Stafford	1
l	4	Marion	2	Stanton	......
	7	Marshall	5	Stevens	......
	1	Meade	......	Sumner	1
n	1	Miami	12	Thomas	......
a	18	Mitchell	1	Trego	......
	12	Montgomery	6	Wabaunsee	6
	......	Morris	5	Wallace	......
	6	Nemaha	9	Washington	3
	......	Neosho	4	Wichita	......
h	......	Ness	2	Wilson	7
	......	Norton	1	Woodson	7
	......	Osage	5	Wyandotte	30
	11	Osbourne	2		
	......	Ottawa	2	Total	5
	......	Pawnee	......		
	......	Phillips	2		

KENTUCKY.

Counties.	Per cent.	Counties.	Per cent.	Counties.	Per cent.
Adair	50	Graves	48	Mercer	[illegible]
Allen	53	Grayson	54	Metcalfe	[illegible]
Anderson	23	Green	39	Monroe	[illegible]
Ballard	53	Greenup	61	Montgomery	[illegible]
Barren	39	Hancock	40	Morgan	[illegible]
Bath	24	Hardin	40	Muhlenburgh	[illegible]
Bell	79	Harlan	88	Nelson	[illegible]
Boone	16	Harrison	17	Nicholas	[illegible]
Bourbon	5	Hart	50	Ohio	[illegible]
Boyd	54	Henderson	33	Oldham	[illegible]
Boyle	21	Henry	21	Owen	[illegible]
Bracken	15	Hickman	46	Owsley	[illegible]
Breathitt	89	Hopkins	47	Pendleton	[illegible]
Breckinridge	51	Jackson	69	Perry	[illegible]
Bullitt	50	Jefferson	20	Pike	[illegible]
Butler	60	Jessamine	12	Powell	[illegible]
Caldwell	44	Johnson	66	Pulaski	[illegible]
Calloway	57	Kenton	16	Robertson	[illegible]
Campbell	17	Knox	73	Rock Castle	[illegible]
Carroll	20	La Rue	42	Rowan	[illegible]
Carter	65	Laurel	64	Russell	[illegible]
Casey	67	Lawrence	57	Scott	[illegible]
Christian	41	Lee	76	Shelby	[illegible]
Clark	12	Leslie	89	Simpson	[illegible]
Clay	78	Letcher	88	Spencer	[illegible]
Clinton	43	Lewis	50	Taylor	[illegible]
Crittenden	51	Lincoln	32	Todd	[illegible]
Cumberland	60	Livingston	53	Trigg	[illegible]
Daviess	32	Logan	39	Trimble	[illegible]
Edmonson	53	Lyon	58	Union	[illegible]
Elliott	70	McCracken	46	Warren	[illegible]
Estill	69	McLean	48	Washington	[illegible]
Fayette	2	Madison	20	Wayne	[illegible]
Fleming	25	Magoffin	79	Webster	[illegible]
Floyd	80	Marion	39	Whitley	[illegible]
Franklin	21	Marshall	50	Wolfe	[illegible]
Fulton	41	Martin	93	Woodford	[illegible]
Gallatin	14	Mason	11		
Garrard	14	Meade	42	Total	[illegible]
Grant	22	Menifee	80		

LOUISIANA.

Ascension	39	Jackson	69	Saint James	[illegible]
Assumption	49	Jefferson	50	Saint John Baptist	[illegible]
Avoyelles	48	La Fayette	8	Saint Landry	[illegible]
Bienville	65	La Fourche	51	Saint Martin's	[illegible]
Bossier	63	Lincoln	53	Saint Mary's	[illegible]
Caddo	54	Livingston	84	Saint Tammany	[illegible]
Calcasieu	50	Madison	55	Tangipahoa	[illegible]
Caldwell	73	Morehouse	64	Tensas	[illegible]
Cameron	12	Natchitoches	71	Terre Bonne	[illegible]
Catahoula	70	Orleans	51	Union	[illegible]
Claiborne	58	Ouachita	65	Vermillion	[illegible]
Concordia	56	Plaquemines	31	Vernon	[illegible]
De Soto	54	Point Coupée	50	Washington	[illegible]
East Baton Rouge	62	Rapides	63	Webster	[illegible]
East Carroll	39	Red River	63	West Baton Rouge	[illegible]
East Feliciana	41	Richland	68	West Carroll	[illegible]
Franklin	72	Sabine	72	West Feliciana	[illegible]
Grant	57	Saint Bernard	53	Winn	[illegible]
Iberia	19	Saint Charles	46		
Iberville	49	Saint Helena	78	Total	[illegible]

MAINE.

Androscoggin	26	Knox	30	Somerset	[illegible]
Aroostook	60	Lincoln	29	Waldo	[illegible]
Cumberland	36	Oxford	48	Washington	[illegible]
Franklin	41	Penobscot	41	York	[illegible]
Hancock	46	Piscataquis	54		
Kennebec	28	Sagadahoc	31	Total	[illegible]

MARYLAND.

Counties.	Per cent.	Counties.	Per cent.	Counties.	Per cent.
.	52	Dorchester	41	Saint Mary's	43
ndol	28	Frederick	20	Somerset	44
(city)	7	Garrett	50	Talbot	28
	25	Harford	28	Washington	21
	32	Howard	29	Wicomico	50
	36	Kent	14	Worcester	45
	20	Montgomery	27		
	27	Prince George's	33	Total	32
	44	Queen Anne	20		

MASSACHUSETTS.

	52	Hampden	30	Suffolk	9
	27	Hampshire	25	Worcester	28
	42	Middlesex	28		
	21	Nantucket	1	Total	30
	23	Norfolk	38		
	27	Plymouth	49		

MICHIGAN.

	82	Huron	47	Montcalm	44
	28	Ingham	25	Montmorency	.....
	78	Ionia	24	Muskegon	53
	71	Iosco	37	Newaygo	52
	51	Isabella	54	Oakland	21
	29	Isle Royale	.....	Oceana	55
	46	Jackson	17	Ogemaw	85
	72	Kalamazoo	17	Ontonagon	55
	28	Kalkaska	75	Osceola	60
	22	Kent	28	Oscoda	.....
	18	Keweenaw	22	Otsego	85
	24	Lake	71	Ottawa	31
	75	Lapeer	29	Presque Isle	86
	70	Leelenaw	68	Roscommon	68
	70	Lenawee	21	Saginaw	44
	59	Livingston	23	Saint Clair	26
	25	Mackinac	71	Saint Joseph	19
	82	Macomb	22	Sanilac	34
	50	Manistee	67	Schoolcraft	69
	27	Manitou	54	Shiawassee	27
	86	Marquette	71	Tuscola	42
	28	Mason	69	Van Buren	28
	74	Mecosta	56	Washtenaw	18
verse	61	Menominee	62	Wayne	21
	45	Midland	56	Wexford	66
	22	Missaukee	73		
	48	Monroe	29	Total	32

MINNESOTA.

	82	Isanti	20	Ramsey	26
	35	Itasca	.....	Redwood	1
	35	Jackson	1	Renville	3
	.....	Kanabec	82	Rice	20
	36	Kandiyohi	6	Rock	.....
	.....	Kittson	1	Saint Louis	72
l	14	Lac-qui-parle	1	Scott	27
	6	Lake	87	Sherburne	21
	81	Le Sueur	45	Sibley	20
	42	Lincoln	1	Stearns	24
	.....	Lyon	1	Steele	7
	2	McLeod	23	Stevens	.....
	57	Marshall	1	Swift	2
	5	Martin	2	Todd	53
	82	Meeker	19	Traverse	.....
d	1	Mille Lacs	41	Wabasha	10
g	15	Morrison	33	Wadena	55
	13	Mower	4	Waseca	8
	8	Murray	.....	Washington	26
	32	Nicollet	11	Watonwan	2
	3	Nobles	.....	Wilkin	1
	17	Olmsted	11	Winona	23
	4	Otter Tail	21	Wright	47
	12	Pine	69	Yellow Medicine	2
	2	Pipe Stone	.....		
	29	Polk	6	Total	15
	36	Pope	6		

MISSISSIPPI.

Counties.	Per cent.	Counties.	Per cent.	Counties.	Per cent.
Adams	32	Jackson	82	Prentiss	[illegible]
Alcorn	58	Jasper	64	Quitman	[illegible]
Amite	67	Jefferson	46	Rankin	[illegible]
Attala	62	Jones	80	Scott	[illegible]
Benton	58	Kemper	56	Sharkey	[illegible]
Bolivar	53	La Fayette	64	Simpson	[illegible]
Calhoun	69	Lauderdale	60	Smith	[illegible]
Carroll	63	Lawrence	75	Sumner	[illegible]
Chickasaw	49	Leake	70	Sunflower	[illegible]
Choctaw	67	Lee	48	Tallahatchie	[illegible]
Claiborne	34	Le Flore	73	Tate	[illegible]
Clarke	47	Lincoln	69	Tippah	[illegible]
Clay	44	Lowndes	40	Tishomingo	[illegible]
Coahoma	64	Madison	38	Tunica	[illegible]
Copiah	58	Marion	82	Union	[illegible]
Covington	77	Marshall	41	Warren	[illegible]
De Soto	39	Monroe	54	Washington	[illegible]
Franklin	70	Montgomery	56	Wayne	[illegible]
Greene	64	Neshoba	74	Wilkinson	[illegible]
Grenada	61	Newton	69	Winston	[illegible]
Hancock	16	Noxubee	40	Yalobusha	[illegible]
Harrison	87	Oktibbeha	49	Yazoo	[illegible]
Hinds	39	Panola	48		
Holmes	43	Perry	88	Total	[illegible]
Issaquena	59	Pike	74		
Itawamba	74	Pontotoc	53		

MISSOURI.

Counties.	Per cent.	Counties.	Per cent.	Counties.	Per cent.
Adair	31	Grundy	23	Perry	[illegible]
Andrew	23	Harrison	21	Pettes	[illegible]
Atchison	10	Henry	19	Phelps	[illegible]
Audrain	11	Hickory	53	Pike	[illegible]
Barry	48	Holt	21	Platte	[illegible]
Barton	12	Howard	28	Polk	[illegible]
Bates	17	Howell	74	Pulaski	[illegible]
Benton	45	Iron	60	Putnam	[illegible]
Bollinger	66	Jackson	23	Ralls	[illegible]
Boone	24	Jasper	19	Randolph	[illegible]
Buchanan	22	Jefferson	62	Ray	[illegible]
Butler	73	Johnson	23	Reynolds	[illegible]
Caldwell	18	Knox	20	Ripley	[illegible]
Callaway	38	Laclede	63	Saint Charles	[illegible]
Camden	71	La Fayette	18	Saint Clair	[illegible]
Cape Girardeau	52	Lawrence	38	Saint Francois	[illegible]
Carroll	20	Lewis	28	Saint Genevieve	[illegible]
Carter	76	Lincoln	42	Saint Louis (city)	[illegible]
Cass	17	Linn	20	Saint Louis	[illegible]
Cedar	53	Livingston	22	Saline	[illegible]
Chariton	22	McDonald	54	Schuyler	[illegible]
Christian	59	Macon	28	Scotland	[illegible]
Clarke	26	Madison	62	Scott	[illegible]
Clay	23	Maries	62	Shannon	[illegible]
Clinton	18	Marion	28	Shelby	[illegible]
Cole	52	Mercer	29	Stoddard	[illegible]
Cooper	30	Miller	68	Stone	[illegible]
Crawford	69	Mississippi	38	Sullivan	[illegible]
Dade	44	Moniteau	38	Taney	[illegible]
Dallas	60	Monroe	23	Texas	[illegible]
Daviess	24	Montgomery	32	Vernon	[illegible]
De Kalb	17	Morgan	44	Warren	[illegible]
Dent	77	New Madrid	51	Washington	[illegible]
Douglas	70	Newton	38	Wayne	[illegible]
Dunklin	51	Nodaway	13	Webster	[illegible]
Franklin	55	Oregon	82	Worth	[illegible]
Gasconade	72	Osage	70	Wright	[illegible]
Gentry	23	Ozark	71		
Greene	44	Pemiscot	74	Total	[illegible]

MONTANA TERRITORY.

Counties.	Per cent.	Counties.	Per cent.	Counties.	Per cent.
Iead	......	Gallatin	1	Missoula	3
	......	Jefferson	......		
	3	Lewis and Clarke	1	Total	1
	......	Madison	......		
dge	......	Meagher	......		

NEBRASKA.

	1	Gage	4	Phelps	......
e	4	Cooper	1	Pierce	......
	......	Greeley	......	Platte	1
	......	Hall	1	Polk	5
	3	Hamilton	1	Red Willow	4
	2	Harlan	2	Richardson	9
	7	Hayes	14	Saline	3
	5	Hitchcock	5	Sarpy	15
	......	Holt	5	Saunders	2
e		Howard	1	Seward	3
	1	Jefferson	3	Sherman	27
	1	Johnson	6	Sioux	......
	3	Kearney	1	Stanton	5
	......	Keith	......	Thayer	3
	7	Knox	3	Valley	......
	1	Lancaster	2	Washington	5
	4	Lincoln	......	Wayne	1
	2	Madison	3	Webster	2
	6	Merrick	2	Wheeler	......
	......	Nance	1	York	2
	1	Nemaha	9	Unorganized ter	4
	2	Nuckolls	4		
	7	Otoe	6	Total	3
	2	Pawnee	5		

NEVADA.

	12	Lander	1	Stoney	......
	12	Lincoln	2	Washoe	5
	2	Lyon	6	White Pine	1
la	......	Nye	5		
	......	Ormsby	......	Total	4
	1	Roop	......		

NEW HAMPSHIRE.

	28	Grafton	36	Strafford	30
	45	Hillsborough	31	Sullivan	26
	40	Merrimack	33		
	45	Rockingham	30	Total	35

NEW JERSEY.

	71	Hudson	4	Salem	14
	20	Hunterdon	11	Somerset	10
on	23	Mercer	11	Sussex	26
	26	Middlesex	19	Union	17
y	39	Monmouth	20	Warren	18
nd	26	Morris	34		
	17	Ocean	53	Total	24
er	18	Passaic	53		

NEW MEXICO TERRITORY.

Counties.	Per cent.	Counties.	Per cent.	Counties.	Per cent.
Bernalillo	41	Mora	19	Taos	[illegible]
Colfax	6	Rio Cerriba	51	Valencia	[illegible]
Doña Aña	7	San Miguel	71		
Grant	24	Santa Fé	......	Total	[illegible]
Lincoln	......	Socorro	18		

NEW YORK.

Albany	14	Jefferson	16	Saint Lawrence	[illegible]
Allegany	27	Kings	2	Saratoga	[illegible]
Broome	25	Lewis	32	Schenectady	[illegible]
Cattaraugus	31	Livingston	17	Schoharie	[illegible]
Cayuga	14	Madison	17	Schuyler	[illegible]
Chautauqua	21	Monroe	8	Seneca	[illegible]
Chemung	20	Montgomery	10	Steuben	[illegible]
Chenango	19	New York	18	Suffolk	[illegible]
Clinton	24	Niagara	10	Sullivan	[illegible]
Columbia	13	Oneida	17	Tioga	[illegible]
Cortland	19	Onondaga	11	Tompkins	[illegible]
Delaware	35	Ontario	15	Ulster	[illegible]
Duchess	16	Orange	23	Warren	[illegible]
Erie	15	Orleans	10	Washington	[illegible]
Essex	42	Oswego	20	Wayne	[illegible]
Franklin	27	Otsego	21	Westchester	[illegible]
Fulton	23	Putnam	25	Wyoming	[illegible]
Genesee	13	Queens	17	Yates	[illegible]
Greene	29	Rensselaer	13		
Hamilton	70	Richmond	17	Total	[illegible]
Herkimer	17	Rockland	38		

NORTH CAROLINA.

Alamance	34	Franklin	55	Pamlico	[illegible]
Alexander	56	Gaston	48	Pasquotank	[illegible]
Alleghany	50	Gates	64	Pender	[illegible]
Anson	53	Graham	80	Perquimans	[illegible]
Ashe	58	Granville	41	Person	[illegible]
Beaufort	82	Greene	51	Pitt	[illegible]
Bertie	64	Guilford	30	Polk	[illegible]
Bladen	85	Halifax	50	Randolph	[illegible]
Brunswick	93	Harnett	76	Richmond	[illegible]
Buncombe	66	Haywood	68	Robeson	[illegible]
Burke	79	Henderson	66	Rockingham	[illegible]
Cabarrus	43	Hertford	64	Rowan	[illegible]
Caldwell	73	Hyde	54	Rutherford	[illegible]
Camden	63	Iredell	47	Sampson	[illegible]
Carteret	73	Jackson	79	Stanley	[illegible]
Caswell	32	Johnston	70	Stokes	[illegible]
Catawba	50	Jones	70	Surry	[illegible]
Chatham	49	Lenoir	57	Swain	[illegible]
Cherokee	82	Lincoln	53	Transylvania	[illegible]
Chowan	52	McDowell	74	Tyrrell	[illegible]
Clay	68	Macon	78	Union	[illegible]
Cleveland	49	Madison	67	Wake	[illegible]
Columbus	89	Martin	72	Warren	[illegible]
Craven	78	Mecklenburg	39	Washington	[illegible]
Cumberland	79	Mitchell	70	Watauga	[illegible]
Currituck	42	Montgomery	74	Wayne	[illegible]
Dare	77	Moore	77	Wilkes	[illegible]
Davidson	42	Nash	64	Wilson	[illegible]
Davie	42	New Hanover	78	Yadkin	[illegible]
Duplin	76	Northampton	53	Yancey	[illegible]
Edgecombe	46	Onslow	78		
Forsyth	42	Orange	47	Total	[illegible]

OHIO.

Counties.	Per cent.	Counties.	Per cent.	Counties.	Per cent.
	39	Hamilton	13	Noble	22
	33	Hancock	34	Ottawa	30
	22	Hardin	35	Paulding	53
	21	Harrison	17	Perry	19
	30	Henry	40	Pickaway	16
	32	Highland	23	Pike	39
	21	Hocking	29	Portage	19
	21	Holmes	26	Preble	25
	16	Huron	14	Putnam	42
	21	Jackson	25	Richland	24
1	22	Jefferson	27	Ross	26
	17	Knox	21	Sandusky	25
	16	Lake	17	Scioto	44
	19	Lawrence	44	Seneca	24
a	22	Licking	17	Shelby	31
	25	Logan	29	Stark	17
	23	Lorain	15	Summit	16
	13	Lucas	27	Trumbull	20
	30	Madison	15	Tuscarawas	20
	43	Mahoning	22	Union	27
	22	Marion	20	Van Wert	42
	12	Medina	18	Vinton	31
	19	Meigs	28	Warren	19
	17	Mercer	39	Washington	25
	17	Miami	20	Wayne	22
	33	Monroe	29	Williams	32
	27	Montgomery	18	Wood	36
	20	Morgan	21	Wyandot	24
	20	Morrow	21		
	22	Muskingum	21	Total	24

PENNSYLVANIA.

	21	Elk	63	Montour	19
	19	Erie	24	Northampton	10
g	27	Fayette	32	Northumberland	21
	25	Forest	60	Perry	39
	47	Franklin	25	Philadelphia	4
	16	Fulton	50	Pike	73
	29	Greene	24	Potter	44
	23	Huntingdon	46	Schuylkill	34
	11	Indiana	30	Snyder	29
	28	Jefferson	44	Somerset	40
	47	Juniata	41	Sullivan	43
	73	Lackawanna	25	Susquehanna	28
	53	Lancaster	10	Tioga	39
	38	Lawrence	20	Union	26
	13	Lebanon	18	Venango	34
	35	Lehigh	12	Warren	47
	51	Luzerne	43	Washington	16
	46	Lycoming	38	Wayne	38
	27	McKean	53	Westmoreland	25
	27	Mercer	24	Wyoming	30
ld	16	Mifflin	36	York	18
	19	Monroe	47		
	10	Montgomery	8	Total	29

RHODE ISLAND.

	16	Newport	12	Washington	33
	43	Providence	42		
				Total	35

SOUTH CAROLINA.

	19	Fairfield	28	Oconee	75
	72	Georgetown	86	Orangeburg	60
	34	Greenville	48	Pickens	60
	60	Hampton	63	Richland	63
	65	Horry	92	Spartanburg	40
1	71	Kershaw	55	Sumter	60
	23	Lancaster	40	Union	26
ld	69	Laurens	21	Williamsburg	79
	66	Lexington	68	York	40
	72	Marion	74		
1	59	Marlborough	62	Total	54
	33	Newberry	21		

TENNESSEE.

Counties.	Per cent.	Counties.	Per cent.	Counties.	Per cent.
Anderson	56	Hancock	57	Morgan	80
Bedford	29	Hardeman	53	Obion	52
Benton	72	Hardin	71	Overton	49
Bledsoe	65	Hawkins	50	Perry	79
Blount	55	Haywood	43	Polk	65
Bradley	48	Henderson	57	Putnam	66
Campbell	71	Henry	50	Rhea	62
Cannon	49	Hickman	73	Roane	60
Carroll	52	Houston	75	Robertson	40
Carter	71	Humphreys	77	Rutherford	37
Cheatham	61	Jackson	61	Scott	87
Claiborne	61	James	59	Sequatchie	71
Clay	64	Jefferson	43	Sevier	69
Cocke	59	Johnson	79	Shelby	37
Coffee	56	Knox	42	Smith	37
Crockett	48	Lake	51	Stewart	72
Cumberland	87	Lauderdale	54	Sullivan	47
Davidson	36	Lawrence	76	Sumner	36
Decatur	70	Lewis	84	Tipton	54
De Kalb	53	Lincoln	39	Trousdale	30
Dickson	68	London	48	Unicoi	80
Dyer	60	McMinn	49	Union	53
Fayettte	37	McNairy	64	Van Buren	42
Fentress	77	Macon	64	Warren	56
Franklin	58	Madison	44	Washington	36
Gibson	46	Marion	68	Wayne	78
Giles	42	Marshall	39	Weakley	52
Grainger	49	Maury	33	White	53
Greene	47	Meigs	56	Williamson	44
Grundy	76	Monroe	63	Wilson	40
Hamblen	37	Montgomery	42		
Hamilton	61	Moore	40	Total	54

TEXAS.

Anderson	73	Comal	10	Gregg	59
Andrews	......	Comanche	46	Grimes	52
Angelina	85	Concho	......	Guadalupe	42
Aransas	......	Cook	28	Halo	......
Archer	......	Coryell	43	Hall	......
Armstrong	......	Cottle	......	Hamilton	17
Atacosta	59	Crockett	9	Hansford	......
Austin	39	Crosby	......	Hardeman	......
Barley	......	Dallam	......	Hardin	90
Bandera	61	Dallas	24	Harris	45
Bastrop	50	Dawson	......	Harrison	56
Baylor	......	Deaf Smith	......	Hartley	......
Bee	26	Delta	44	Haskell	......
Bell	30	Denton	37	Hayes	21
Bexar	39	De Witt	25	Hemphill	......
Blanco	60	Dickens	......	Henderson	75
Borden	......	Dimmit	76	Hidalgo	97
Bosque	33	Donley	13	Hill	22
Bowie	61	Duval	10	Hockley	......
Brazoria	39	Eastland	69	Hood	39
Brazos	54	Edwards	91	Hopkins	44
Briscoe	......	Ellis	10	Houston	76
Brown	40	El Paso	23	Howard	......
Burleson	61	Encinal	......	Hunt	28
Burnet	54	Erath	56	Hutchinson	......
Caldwell	33	Falls	32	Jack	67
Calhoun	......	Fannin	42	Jackson	18
Callahan	46	Fayette	42	Jasper	74
Cameron	30	Fisher	......	Jefferson	20
Camp	64	Floyd	......	Johnson	25
Carson	......	Fort Bend	50	Jones	......
Cass	69	Franklin	66	Karnes	12
Castro	......	Freestone	67	Kaufman	25
Chambers	17	Frio	26	Kendall	68
Cherokee	72	Gaines	......	Kent	......
Childress	......	Galveston	4	Kerr	14
Clay	4	Garza	......	Kimble	......
Cochran	......	Gillespie	30	King	......
Coleman	12	Goliad	17	Kinney	38
Collin	26	Gonzales	57	Knox	......
Collingsworth	......	Gray	......	Lamar	45
Colorado	35	Grayson	25	Lamb	......

VIRGINIA—Continued.

Counties.	Per cent.	Counties.	Per cent.	Counties.	Per cent.
Greensville	53	Nansemond	62	Rockingham	35
Halifax	32	Nelson	47	Russell	61
Hanover	40	New Kent	52	Scott	54
Henrico	37	Norfolk	52	Shenandoah	41
Henry	46	Northampton	40	Smyth	
Highland	64	Northumberland	49	Southampton	—
Isle of Wight	67	Nottoway	39	Spottsylvania	52
James City	55	Orange	34	Stafford	53
King and Queen	43	Page	47	Surry	49
King George	41	Patrick	63	Sussex	45
King William	45	Pittsylvania	41	Tazewell	62
Lancaster	52	Powhatan	43	Warren	39
Lee	60	Prince Edward	35	Warwick	22
Loudoun	21	Prince George	47	Washington	47
Louisa	43	Princess Anne	50	Westmoreland	46
Lunenburg	41	Prince William	46	Wise	50
Madison	40	Pulaski	46	Wythe	45
Matthews	35	Rappahannock	31	York	38
Mecklenburg	45	Richmond	43		
Middlesex	39	Roanoke	45	Total	46
Montgomery	50	Rockbridge	46		

WASHINGTON TERRITORY.

Chehalis	53	Klikitat	15	Stevens	......
Clallam	65	Lewis	62	Thurston	46
Clarke	64	Mason	85	Wahkiakum	81
Columbia	2	Pacific	39	Walla Walla	5
Cowlitz	59	Pierce	39	Whatcom	66
Island	34	San Juan	57	Whitman	1
Jefferson	71	Skamania	52	Yakima	4
King	65	Snohomish	69		
Kitsap	95	Spokane	3	Total	31

WEST VIRGINIA.

Barbour	43	Kanawha	70	Putnam	61
Berkeley	25	Lewis	49	Raleigh	73
Boone	85	Lincoln	73	Randolph	77
Braxton	69	Logan	89	Ritchie	61
Brooke	28	McDowell	89	Roane	65
Cabell	49	Marion	35	Summers	72
Calhoun	74	Marshall	39	Taylor	33
Clay	75	Mason	48	Tucker	77
Doddridge	64	Merced	70	Tyler	41
Fayette	70	Mineral	63	Upshur	49
Gilmer	71	Monongalia	34	Wayne	67
Grant	61	Monroe	50	Webster	84
Greenbrier	73	Morgan	60	Wetzel	60
Hampshire	63	Nicholas	71	Wirt	67
Hancock	28	Ohio	16	Wood	48
Hardy	76	Pendleton	77	Wyoming	75
Harrison	28	Pleasants	53		
Jackson	60	Pocahontas	70	Total	61
Jefferson	15	Preston	55		

WISCONSIN.

Adams	48	Dodge	12	Kenosha	10
Ashland	......	Door	41	Kewaunee	44
Barron	46	Douglas	27	La Crosse	40
Bayfield	73	Dunn	29	La Fayette	16
Brown	38	Eau Claire	23	Langlade	59
Buffalo	25	Fond du Lac	15	Lincoln	82
Burnett	52	Grant	32	Manitowoc	32
Calumet	30	Green	21	Marathon	77
Chippewa	46	Green Lake	18	Marinette	28
Clark	59	Iowa	36	Marquette	43
Columbia	23	Jackson	23	Milwaukee	15
Crawford	51	Jefferson	14	Monroe	28
Dane	22	Juneau	38	Oconto	60

WISCONSIN—Continued.

Counties.	Per cent.	Counties.	Per cent.	Counties.	Per cent.
Outagamie	33	Rock	14	Washington	26
Ozaukee	21	Saint Croix	15	Waukesha	18
Pepin	35	Sauk	40	Waupaca	50
Pierce	38	Shawano	70	Waushara	40
Polk	54	Sheboygan	26	Winnebago	14
Portage	47	Taylor	89	Wood	64
Price	93	Trempealeau	21		
Racine	11	Vernon	48	Total	31
Richland	52	Walworth	17		

WYOMING.

Albany	......	Johnson	1	Uintah	......
Carbon	......	Laramie	1		
Crook	......	Sweetwater	......	Total	......

AGRICULTURAL PRODUCTION FOR AMERICAN CONSUMPTION.

It is a truth that escapes recognition by multitudes of the American people that the products of the agriculture of this country are mostly consumed at home, and it is a certainty that this will be the case in the future. Our agriculture is primitive, even crude, on a large proportion of its area. There is a want of harmony in the distribution of crops, which a higher culture, with time and experience, will cure. There is too much area devoted to some crops, too small a rate of yield upon that area, and too little breadth to other crops. Were it the result of climatic difficulties or other natural hindrances, it might not be wise to seek to change these crop relations. But with a continent for industrial exploitation—almost a world in itself—it is rank stupidity to assume that the necessities of a great people in consumption of all products grown in temperate climates cannot be supplied from the resources of home soil and labor.

Our production in certain directions has been excessive. While population doubled in twenty-seven years, the wheat area doubled in fifteen. There were four millions of farms in 1880, and but two millions in 1860. The maize crop of one year is equal to the product of four years in Europe. The supply of wheat per capita was only 4.33 bushels in 1849, 5.5 in 1859, 7.46 in 1869, and 9.2 in 1879. We might produce 20 bushels per capita, but it would be folly to do it. The area in wheat is now 39,475,000 acres, and 12,000,000 acres are cultivated in excess of the wants of the country, the produce of which must be sold abroad, mainly in Liverpool, in competition with the grain of Russia, of South America, of Australia, and of India. It is sent 1,500 miles by land and 3,500 miles by sea, and from California more than half round the world, to compete with the half-civilized fellahs of Egypt and the slavish ryots of India. It is a competition unworthy of American freemen, and utterly unnecessary, being caused by bad calculation in the distribution of crop areas, for while we export one-third of the wheat production, we import one-seventh of all the barley consumption, and $100,000,000 worth of sugar at foreign valuation, which brings $150,000,000 in our local markets in addition to the costs and profits of refining here.

This inequality of production is the result of temporary conditions, which, it is hoped, the good sense and correct judgment of farmers remedy in the early future. The pioneer settler is far less a farmer than a speculator. At present he is engaged in a land speculation, appropriating acres from an unoccupied domain to bequeath to posterity, possibly a little reduced in productiveness, but certainly largely hanced in price. And he finds it convenient to grow wheat year a year, till the weeds choke out all growth, with little labor and no vation, to get the ready cash with which to construct houses and b build fences, buy plows and reapers, and more cheap land. At a day the pioneer or his successor will be quite as progressive as advanced cultivator of the older settlements.

It is conceded that we might possibly produce a surplus of breadstuffs sufficient to feed two or three small nations of Europe, but that it would be both impolitic and unprofitable to do it. We have both the land and the labor, but prefer to have a wiser distribution of labor production. Doubtless our customers in Europe would find it profitable if unequal distribution of productive effort should produce a gr surplus of cotton, wheat, maize, or meat. Not many years have elap since cotton-growers were compelled to accept $45,000,000 less for a crop of four and a quarter million bales than they received for the preceding crop of three million bales.

The facts of industry and wealth in history of nations show that general thrift and national wealth do not depend on numbers, but upon a wise distribution of productive forces. Labor that is inharmonious and unequal in its distribution among the industries is unremunerative.

If nearly all workers are in agriculture, there may be abundance of food, and but few other comforts or appliances of civilization, and little money to procure any. Agricultural nations are proverbially poor. In India 70 per cent. are engaged in agriculture, yet its products have been estimated at a value of $8 per capita; in this country 44 per cent. are so engaged, and agricultural production averages $64 for every man, woman, and child of the population. So it is everywhere in Europe as well as in less favored quarters of the globe.

Should we so unequally distribute labor as to be compelled to sell grain to buy dry goods, there is a bar to the disposal of a large surplus in the fact that few nations can afford to buy, or pay for if bought, except to a very limited extent. Fifteen years ago, when our export of grain was far less than at present, less than three per cent. of our wheat surplus went to all other countries exclusive of Great Britain and her dependencies.

Again, while our agricultural surplus is greater than that of any other country on earth, it is insignificant compared with the volume of our consumption. We exported in 1883 products valued at—

Three hundred and sixty-two million dollars, and the same year had to pay from this sum two hundred and forty millions for food and drink imported, besides large additional sums for transportation and commissions. When we remember that these exports are reckoned in sea-board prices, and that farm prices are only half or two-thirds as much, the difference between shipments and receipts is narrowed down to a sum that is small, if not insignificant, compared with the value of the home consumption. After paying for imports of food and beverages with exports, it is found that only 2 or 3 per cent. of a net surplus of material for subsistence is left, and that is an exceptionally large national showing. Other countries balance far more nicely their little exchanges of food products. Nations must be independent in the matter of subsistence or risk their very existence. We cannot depend on Europe for a market for our farm products. There must be such distribution of labor here that the farmer can get a fair price for his productions without hawking them around the world to be eaten up by an army of carriers and forwarders.

Our cotton is exceptional. We produce nearly two-thirds of all grown in the world, and find it profitable to supply fiber for the spindles of Europe. We consume a third, and shall, ere long, manufacture one-half, and should ultimately use two-thirds in domestic manufacture. But in cotton, in food products, and all other exports, the exportation is but one-twelfth of the production.

We can produce a surplus by neglecting production in other directions, but we cannot sell, if produced beyond a limited quantity, and then only by accepting the prices that our customers choose to give.

The importance of home supply of home wants can scarcely be overestimated.

The domestic trade of a country [as I have heretofore written] is always the principal commerce. In this country the foreign trade probably represents scarcely $1 to $20 of the grand volume of mercantile transactions. It might be less without the slightest inconvenience to a human being, the importer alone excepted. With an area bounded by the two great oceans of the globe, and touching the domain of everlasting ice on one side and that of tropical temperature on the other, there is little need to go beyond its boundaries for anything. This continental area includes a range of elevation occupied in agriculture of 7,000 feet, giving variety of climate and production without regard to latitude. North Carolina and New Hampshire have a range of 6,000 feet, and California still greater difference of altitude. North Carolina produces rice and wheat, figs, and apples, and can supply both ice and sugar for its insidious yet popular potations of peach brandy. The productions of the United States range from lichens to lemons, and include the fruits of all zones, from gooseberries to guavas. With these resources of soil and sun, of coal and iron, of gold and silver, of water for transportation and for power, of mind and muscle, of skill and genius, how stupid the folly of desuetude, how abject the shame of inanity, how injurious the crime of idleness. To go thousands of miles for that which we can produce from our surplus labor would be burning the candle at both ends and drifting into the darkness of national poverty.

Our population doubled in twenty-seven years from 1853. It is estimated that it will double again in thirty years from 1880 to 1910. Then 100,000,000 of people will be fed and clothed. Will there be no further increase? It may not be practicable to indicate the time when population shall again be doubled, and again. The probability is strong, however, that 400,000,000 people may exist within the present limits of the United States, if not within one hundred years, quite reasonably within two centuries. Where will American production then find a market for its crude products of agriculture if not at home?

INTERNAL AND EXTERNAL COMMERCE.

Compared with the domestic demand, the foreign is utterly insignificant, either for agricultural or manufactured products. The foreign trade has received a recognition in the public mind far beyond its relative importance. Until recently our exports of merchandise failed to yield money enough to pay for imports, and the production of our mines went to pay the balance. In forty years of the last half century only nine had a balance in favor of imports; in the last ten, owing to crop failures in Europe and extension of crop area on millions of acres of land given away to native and foreign-born citizens, the balance has favored exports. The comparison is as follows:

1835–1874—excess of imports	$1,579,829,806
1875–1884—excess of exports	1,360,482,467

During the fifty years exports were in debt to imports $219,347,339. So we have failed by that amount to produce enough for home consumption. But our deficiency is far greater, because the values of imports are known to be understated, and they are always the value at foreign ports, upon which the cost of freights and commissions must accrue.

To pay for this excess of imports our gold and silver must and the exeess of such exports over imports in fifty years am w $1,068,561,548. So the excess of these payments over the appa debtedness from excessive imports of merchandise is $849,214, average draft of $16,984,284 per annum for the entire period. I that immigrants bring money and other effects, which add to the of our country, and far more than balances the above deficiency. fact remains, nevertheless, that the domestic production of the U States fails to equal, by a very small difference, the consumption of United States.

This matter is understood by intelligent publicists in this country, and is seen in its true light by enlightened foreigners, who admit nations must be self-supporting if they would live at all, and t t domestic trade of every country must dwarf to insignificance its fo n commerce. The apparent exception of Great Britain, which occu s peculiar and isolated position, is not an exception, because of the p sessions of Englishmen in British colonies all over the world, and in an other countries, especially the United States. The imports of t country are largely dividends and profits on foreign investments, are thus practically, in a peculiar sense, domestic trade as well.

The grain supply will hereafter be in larger proportion for do consumption, the cotton demand will continue to move in the dire n of larger domestic manufactures, and the pork trade will be in lar proportion consumed at home. These three products, which a monopolize the export trade, have all been the result of undue stimu tion, of a disproportionate distribution of farm labor and crop ar while other products needed for consumption have been unnec y scarce and high. The excess of wheat-growing has brought p es to a ruinous point when sound grain can be bought in Dakota for 40 cents, and again in London for a dollar a bushel. It is down close to India rates.

It is not desirable that cotton or wheat should be neglected, or substituted abruptly by other crops. All of the former that the world requires should be furnished, hereafter as heretofore, largely by this country, but the most of it should and will be manufactured here, very largely on the borders of the cotton-fields. But it is very certain, that twenty-five dollars worth of cotton per head will make no community rich; it is not less cotton that is wanted, but more of something else. The wheat specialist is still less excusable for neglecting other farm products. We have an advantage of the world in cotton production, in soil and climate especially suited to its growth; we have none over many other countries in wheat production, except in agricultural implements. The crudest of agriculture produces as much per acre, the most skilled twice as much. The cheapest of labor competes in its production, and our acceptance of the competition is a confession that we lack the enterprise or the skill to produce what we need more and buy at higher cost. Yet we should rearrange our crop areas slowly and judiciously, producing all the wheat required for home consumption, some to give to starving foreign peoples in an emergency, and a small surplus for sale whenever something more than starvation prices are offered for it. Half the present area in wheat should produce all the present product; when, with rotation and intensive culture, an equal or greater value would result, from the superior cultivation of other crops in the remaining half, and the net profit might be fourfold the present gain. It is a more profitable distribution of crops that is wanted; it is greater variety, larger aggregate quantity, greater indi-

vidual and far greater total value, and better returns for the farmer's labor that are desired; more home consumption, and export of the crumbs that fall from the home table.

The inevitable deduction from these facts is that American agriculture can prosper only with an American policy, which shall produce its own supplies, feed its own people, and enlarge the proportion of its workers who are outside of agriculture and dependent upon it for food and material for fabrication. It teaches that, instead of overproduction, we have consumed more than has been produced in value but not in quantity, excepting the lowest prices of the world for two or three products of overproduction and paying high rates for products not produced in sufficient quantity. The more we buy abroad the less of manufactured products we produce at home, while farmers increase and farm products cheapen from decline of home markets. It is a suicidal policy to sell and export the soil in raw products of agriculture.

SURPLUS PRODUCTS OF AGRICULTURE.

Fifty years ago there was only a fourth of the present population. The wants of the larger number are now more liberally supplied than ever were the limited requirements of a more primitive mode of living. The use of labor-saving machinery and appliances has enlarged and cheapened production; and the surplus, which is sent to foreign countries, is not only four times as much as in 1830, but is thirteen times as much. The agricultural exports of 1883 were 619,269,449, and the average has been about that figure for five years past.

Not only has there been a vast increase, but the history of this progress affords a lesson in industrial economy which farmers cannot afford to overlook. It illustrates in a striking way the necessity of the greatest possible diversity in rural industry.

Fifty years ago unmanufactured cotton comprised about 60 per cent. of the value of our exports, and breadstuffs and animals and their products, counted together, brought only a third as much. Now, while the exports of cotton in 1883 were worth nine times as much as in 1825–'30, the values of animal products and breadstuffs are thirty times as much as the surplus of half a century ago. The rapidity of the increase has therefore been fully three times as great as in the case of cotton. The early prominence of cotton in our exports was phenomenal. In ten States extension of this one industry became an absorbing passion, dominating agriculture, society, and politics. All other agriculture was dwarfed in this section. With millions of acres of wasted pasturage, almost no wool was grown or manufactured, and clothing was bought on credit at enormous prices. With millions of acres in forests, wash-tubs and ax-helves were brought a thousand miles; a mill-log would not sell for enough to buy a hammer-handle. The cultivator employed his horses and mules during the spring and summer in killing grass, and in autumn and winter alternately in hauling out cotton and bringing in hay that had floated down the great river from the West. Hogs grew wild and multiplied in the swamps, while the thrifty merchant got 50 per cent. profit on Western bacon.

It became a cherished theory in political economy that the South should produce cotton, the West hogs, and the East "notions," and everything else should be brought 5,000 miles—from Europe. This continued until there was little produced but cotton, and much of that was mortgaged a year in advance to procure the necessaries of life.

The following table, from official records of exports, presents the prog-

ress of exportation and illustrates the rapidity of increase in volume and the wonderful change in the character of the export trade:

Comparison of cotton exports with those of breadstuffs and animal products.

Years.	Cotton, unmanufactured.	Per cent.	Breadstuffs.	Per cent.	Animals and their products.	Per cent.	Total exports of agriculture.	Per cent.	Total domestic exports.
1830* ...	$29,674,883	61.7	$7,071,767	14.7	$2,533,318	5.3	$48,095,184	82.18	
1840* ...	63,870,207	69.0	13,535,926	14.6	3,065,719	3.3	92,548,067	82.93	
1850 ...	[illegible]984,616	66.3	13,066,509	12.0	10,667,438	9.8	108,605,713	80.51	[illegible]
1860 ...	191,806,555	74.8	24,422,310	9.5	20,402,812	8.0	256,560,972	81.14	[illegible]
1870 ...	227,027,624	62.9	72,250,933	20.0	33,049,268	9.2	361,188,483	79.34	455[illegible]
1871 ...	218,327,109	59.3	79,381,187	21.5	42,172,961	11.4	368,466,011	77.07	478[illegible]
1872 ...	180,684,595	49.0	84,586,273	22.9	68,678,144	18.6	368,796,625	77.41	47[illegible]
1873 ...	227,243,069	50.8	98,743,151	22.1	89,605,570	20.1	446,900,004	77.69	57[illegible]
1874 ...	21[illegible],223,580	42.1	161,198,864	32.2	90,560,332	18.1	501,871,501	79.16	60[illegible]
1875 ...	190,638,625	44.3	111,458,065	25.9	91,555,115	21.3	430,306,570	76.95	559,237,638
1876 ...	192,659,262	42.2	131,181,555	28.8	98,434,230	21.6	456,113,515	76.67	594,917,715
1877 ...	171,118,508	37.2	117,806,476	25.6	125,679,800	27.3	459,734,148	72.63	632,980,854
1878 ...	180,031,484	33.6	181,777,841	33.9	134,080,874	25.0	536,192,873	77.07	695,749,930
1879 ...	162,304,250	29.7	210,355,528	38.5	134,779,947	24.7	546,476,703	78.12	699,538,742
1880 ...	211,535,905	30.8	288,036,835	42.0	150,583,442	21.9	685,961,091	83.25	823,946,353
1881 ...	247,695,746	33.9	270,332,519	37.0	175,584,780	24.0	730,394,943	82.63	883,925,947
1882 ...	199,812,644	36.2	182,670,528	33.1	134,323,940	24.3	552,219,819	75.31	733,239,732
1883 ...	247,328,721	39.9	208,040,850	33.6	122,513,653	19.8	619,269,449	77.00	804,223,632

* Year ended September 30.

From 1861 to 1866 breadstuffs realized more than cotton, for obvious reasons.

In 1878 the value of breadstuffs alone exceeded that of cotton. The kingly plant had been distanced for the first time in a fair race. The wants of the stomach were greater than those of the back. In the three following years similar superiority in the exports occurred. The bad harvests of 1881, reducing products and raising prices temporarily, changed the relative values of these classes of exports for two years past. So we may say that while cotton brought four times as much foreign exchange as was obtained from grain fifty years ago, grain is now a more potent factor in our foreign trade than cotton, and has been worth more in exchanges for the past seven years; that is, the exports of breadstuffs have averaged $208,431,511 per annum since 1876, and of cotton $202,832,465. Thus either cotton or bread separately represent more than four times the aggregate values of all agricultural exports prior to 1830.

This comparison, so favorable to cereals, is no disparagement to cotton, the product of an industry which cannot be extended more rapidly except by a loss in value. The experiment has been tried with disastrous results, an increase of over a million bales in a single year having reduced the value of the crop $45,000,000. The extension can be profitably made only by keeping pace with the gradually increasing consumption of the world.

Up to 1860 cotton far surpassed in export values both bread and meat products, either taken separately or together, and in no year did the sum of the latter equal the value of the former. But the experience of the four years following, when the absence from rural and other industries of one to two million men, and the necessity for ample supplies of bread and meat, for soldier and civilian, stimulated the invention and energy of manufacturers of agricultural implements, and furnished abundant supplies, not only for camp and farm and city market, but for exportation; so that in four years of war and waste there was exported a value of $291,074,078 in breadstuffs, and $228,912,232 in animals and their products, a surplus of bread and meat of about $130,000,000 per annum, a sum greater than any annual exports of cotton up to 1856.

What cares a country of such resources of soil and labor for a single article of export, however kingly, which can recoup its loss in such a manner in a single decade? During this period the total export of cotton, officially reported by its customs officers, was but $24,564,772.

Here was vantage gained which could not be lost, and we find that in the eighteen subsequent years the exports of cotton have aggregated $3,665,940,553, while the exports of grain and animals and their products—"bread and meat"—make together a total of $4,010,418,722.

The following statement—first, of the exports of four years, and afterwards in two periods of seven years each—illustrates the cumulative force of the foreign movement of grain and provisions, which is the most remarkable ever presented in the world's history:

Years.	Cotton.	Breadstuffs.	Animal products.
1866-'69	798,309,431	205,225,449	115,820,432
1870-'76	1,447,803,864	738,800,228	514,055,620
1877-'83	1,419,827,258	1,459,020,577	977,496,416
Total	3,665,940,553	2,403,046,254	1,607,372,468

Taking the values of twenty-two years, from 1861, that of the eatables exceeds the value of cotton by more than a billion dollars. Cotton may still be princely, but the realm of bread and meat is kinglier still.

The lesson which these facts teach is unmistakable. All natural resources should be utilized—the glassy glade for the dairy, the hill crest and slope for fruit, the bottom lands for corn, tillable uplands for various crops in rotation, and no great district should be restricted to one product, whether cotton or wheat. Such restriction will in one generation lead to poverty of land and people. All natural resources should be realized—the underlying ore, the coal, lime, kaolin, building stone, salt springs—beneath the soil as well as the soil itself. This use of nature, so varied and comprehensive, can alone secure the full utilization and productiveness of labor, and the highest averaged wealth and culture.

AGRICULTURAL EXPORTS OF 1883-'84.

Statement of the exports of agricultural products of the United States during the fiscal year ended June 30, 1884.

Products.	Quantity.	Value.
Animals:		
Cattle ... number..	190,518	$17,855,495
Hogs ... do....	46,382	627,480
Horses ... do....	2,721	424,317
Mules ... do....	3,742	490,809
Sheep ... do....	278,874	850,146
All other, and fowls	....	45,282
Bones, hoofs, horns, horn tips, strips, and waste	....	199,242
Casing for sausages	....	499,134
Eggs ... dozen..	295,484	62,759
Glue ... pounds..	222,313	36,386
Grease, grease scraps, and all soap stock	....	715,650
Hair, and manufactures of	....	640,939
Hides and skins other than furs	....	1,304,329
Oils:		
Lard ... gallons..	712,696	504,218
Other animal ... do....	159,486	150,118
Provisions (comprising meat and dairy products):		
Beef products—		
Beef, canned	....	3,173,767
Beef, fresh ... pounds..	120,784,064	11,987,331
Beef, salted or pickled ... do....	42,379,911	3,202,275
Beef, other cured ... do....	641,163	67,758
Tallow ... do....	63,091,102	4,793,375

Statement of the exports of the agricultural products of the United States, &c.—Continued.

Products.	Quantity.	Value.
Provisions (comprising meat and dairy products)—Continued.		
Mutton .... pounds..	2,982,855	[illegible]
Oleomargarine—		
Imitation butter .... do....	1,537,682	[illegible]
The oil .... do....	37,785,159	[illegible]
Pork products—		
Bacon .... do....	341,579,410	[illegible]
Hams .... do....	47,919,958	[illegible]
Pork, fresh .... do....	185,417	[illegible]
Pork, salted or cured .... do....	60,363,313	[illegible]
Lard .... do....	265,094,719	[illegible]
Poultry and game	....	[illegible]
All other meat products	....	[illegible]
Dairy products—		
Butter .... pounds..	20,627,374	[illegible]
Cheese .... do....	112,869,575	[illegible]
Milk	....	[illegible]
Wax, bees' .... pounds..	51,748	[illegible]
Wool, raw .... do....	10,393	[illegible]
Total value of animals and animal products	....	[illegible]
Breadstuffs:		
Barley .... bushels..	724,955	[illegible]
Bread and biscuit .... pounds..	17,580,740	[illegible]
Indian corn .... bushels..	45,247,490	[illegible]
Indian-corn meal .... barrels..	252,779	[illegible]
Oats .... bushels..	1,760,376	[illegible]
Oatmeal .... pounds..	27,256,427	[illegible]
Rye .... bushels..	6,220,206	[illegible]
Rye flour .... barrels..	4,564	[illegible]
Wheat .... bushels..	70,349,012	[illegible]
Wheat flour .... barrels..	9,152,260	[illegible]
All other breadstuffs	....	[illegible]
Rice .... barrels..	163,519	[illegible]
Total value of breadstuffs, &c	....	[illegible]
Cotton, raw:		
Sea Island .... pounds..	3,598,866	[illegible]
Other unmanufactured .... do....	1,858,973,664	195,854,531
Total value raw cotton	....	[illegible]
Miscellaneous:		
Broom-corn	....	[illegible]
Fruits:		
Apples, dried .... pounds..	5,558,746	[illegible]
Apples, green or ripe .... barrels..	105,400	[illegible]
Fruits, preserved—		
Canned	....	[illegible]
Other	....	[illegible]
All other green, ripe or dried	....	[illegible]
Hay .... tons..	16,908	[illegible]
Honey	....	[illegible]
Hops .... pounds..	13,516,643	[illegible]
Oil cake and oil meal .... do....	524,847,331	[illegible]
Oils:		
Cotton-seed .... gallons..	3,605,946	[illegible]
Linseed .... do....	72,221	[illegible]
Other vegetable	....	[illegible]
Seeds:		
Clover .... pounds..	27,404,737	[illegible]
Cotton .... do....	5,674,560	[illegible]
Timothy .... do....	6,836,394	[illegible]
All other	....	[illegible]
Sugar and molasses:		
Molasses and sirup .... gallons..	5,906,005	[illegible]
Sugar, brown .... pounds..	202,079	[illegible]
Tobacco:		
Leaf .... pounds..	192,130,820	17 [illegible]
Stems and trimmings .... do....	15,026,867	[illegible]
Vegetables:		
Onions .... bushel..	69,494	[illegible]
Peas and beans .... do....	201,106	[illegible]
Potatoes .... do....	554,613	[illegible]
Vegetables, canned	....	[illegible]
All other, including pickles	....	[illegible]
Wine:		
In bottles .... dozen..	5,463	[illegible]
Not in bottles .... gallons..	83,951	[illegible]
All other agricultural products	....	[illegible]
Total value of miscellaneous products	....	[illegible]

RECAPITULATION.

Animals and animal products	$138,779,207
Breadstuffs, &c	162,554,585
Cotton, raw	197,015,204
Miscellaneous products	37,966,322
Total agricultural exports	536,315,318
Total exports	724,964,852
Per cent. of agricultural matter	74.0

ONTARIO STATISTICS.

The secretary of the Bureau of Industry of Ontario, Canada, Mr. A. Blue, reports on the 1st of August continued improvement of the winter-wheat crop, which in May was thought to be nearly ruined, and its harvesting in good condition, plump, hard, and bright.

Equally favorable report is made of the spring wheat, except in the northern and northwestern counties. The estimated area and product are compared with estimates of last year.

Description.	1884.		1883.	
	Acres.	*Bushels.*	*Acres.*	*Bushels.*
Fall wheat	864,551	18,479,207	1,006,206	11,644,005
Spring wheat	722,410	13,251,137	586,410	9,726,063
Total	1,586,961	31,730,344	1,682,616	21,370,068

In some parts of the province barley was short, both in straw and head, in consequence of drought, but the berry was plump and heavy. Some samples are discolored by showery weather during harvest. The oats crop promised to be satisfactory, though not equal to the excellent crops of last year. Rye was nearly all harvested and the crop was generally good. Corn was unpromising, especially in those parts of the province where it is most largely grown. With favorable conditions for the remainder of the season the pea crop promises to be one of the largest ever reaped in the province, and beans also promise well. Condition of potatoes is above the average in quantity and quality, except in Bruce County and portions of a few other counties.

The hay and clover crops, which early in the season promised to be very heavy, were somewhat impaired by frost at the end of May and by drought in June; but they are pronounced a fair average in quantity, while the quality is said to be excellent.

Small fruits are generally abundant, and the same is true as to wild fruits, but most others suffered so seriously from the frost in the last days of May that the crop which had promised to be extraordinarily large will hardly reach a low average, except along the westerly shores of Lake Ontario or the shore of Lake Huron, and in the vicinity of Lake Saint Clair and the Detroit River. Of apples—the staple fruit—there is hardly half a crop, except in the Lake Ontario, Lake Huron, and Georgian Bay counties, and in Oxford, Brant, Perth, and some of the counties on the Saint Lawrence.

Pasture land was in fine condition early in the summer, and suffered from drought in June and the early part of July, but was not so severely parched as to prevent a prompt recuperation under the influence of the rains of July.

Live stock in general is described as in good health and condition.

An unusually large quantity of dairy produce of superior quality is generally reported.

Wages in haying and harvest were decidedly lower than last year. The slow ripening of the crops this season enabled the farmers to extend the harvest through a longer period, and this, together with the introduction of many self binding reapers, reduced the demand for harvest hands. In Western and Central Ontario the average wages were about $1.25 a day, or (for short engagements during the harvest) $25 to $30 a month, with board. For the eastern end of the province the rates were considerably lower, the average day-wages being stated at $1, and the wages per month, with board, at $18 to $25. By the year, wages are $167 this year; last year, $173; if not boarded, $257, instead of $264 last year.

The following tables present the estimate of two years for the cereals and leguminous crops:

Crop.	1884.		1883.	
	Acres.	*Bushels.*	*Acres.*	[illegible]
Fall wheat	864, 551	18, 479, 207	1, 096, 206	[illegible]
Spring wheat	722, 410	13, 351, 137	586, 410	9, [illegible]
Barley	701, 435	17, 860, 777	757, 156	18, [illegible]
Oats	1, 485, 020	53, 195, 805	1, 418, 309	54, 57[illegible]
Rye	104, 141	1, 621, 667	188, 111	3, 01[illegible]
Peas	570, 628	13, 253, 986	542, 771	10, 67[illegible]
Corn	174, 834	....	214, 237	....
Buckwheat	65, 921	....	67, 802	....
Beans	24, 877	552, 953	25, 907	....

Other crops are thus estimated for 1883 and 1884:

Description.	1884.	1883.
Hay and clover ... acres	2, 193, 369	2 [illegible]
Do ... tons	3, 044, 912	4, [illegible]
Potatoes ... acres	168, 862	[illegible]
Mangel-wurzel ... do	18, 341	17[illegible]
Carrots ... do	10, 980	[illegible]
Turnips ... do	104, 108	
Pasture ... do	2, 794, 986	....
Butter ... pounds	....	32, [illegible]
Working horses ... number	303, 474	
Breeding mares ... do	93, 910	
Unbroken horses ... do	138, 569	
Working oxen ... do	16, 793	
Milch cows ... do	710, 519	[illegible]
Store cattle over two years ... do	384, 453	
Young and other cattle ... do	813, 905	[illegible]75
Coarse-wooled sheep ... do	1, 590, 604	1, 623, 175
Fine wooled sheep ... do	300, 120	245, 609
Pigs over one year ... do	257, 711	245, 996
Pigs under one year ... do	658, 447	660, 731
Turkeys ... do	445, 532	355, 635
Geese ... do	540, 130	491, 033
Other fowls ... do	5, 251, 944	5, 000, 610
Coarse wool ... pounds	5, 597, 643	5, 829, 063
Fine wool ... do	921, 275	778, 755

Farm products of the Dominion of Canada.

Products.	1851.	1861.	1871.	1881.
Spring wheat .... bushels..	16,260,285	28,212,760	10,623,851	12,102,817
Winter wheat .... do....			6,369,408	20,247,452
Barley .... do....	1,391,615	5,690,988	11,672,479	16,844,868
Oats .... do....	23,168,468	45,625,768	45,618,029	70,493,131
Rye .... do ...	869,389	1,934,583	1,064,358	2,097,180
Peas and beans .... do....	4,483,986	12,351,377	10,127,687	13,749,662
Buckwheat .... do ...	2,071,352	3,648,450	3,801,593	4,901,147
Corn .... do ...	2,189,789	2,624,100	3,805,241	9,025,142
Potatoes .... do ...	14,181,484	38,934,877	50,705,913	55,268,227
Turnips .... do....	4,458,998	2,803,353	24,734,834	39,059,094
Other roots .... do ...	500,908	3,091,209	3,356,251	9,192,320
Grass and clover seed .... do....	57,902	132,623	360,468	324,317
Seed .... do....	....	....	118,044	108,694
Apples .... do....	....	168,484	6,365,315	13,377,655
Other fruits .... do ...	....	4,335	358,963	841,219
Grapes .... pounds..	....	....	1,126,402	3,896,508
Home-made butter .... do....	32,336,397	51,564,888	75,172,523	102,545,169
Home-made cheese .... do....	3,628,953	4,601,965	5,140,367	3,184,996
Flax and hemp .... do....	....	....	2,612,046	2,056,353
Tobacco .... do....	1,210,553	....	1,595,932	2,527,962
Hops .... do....	260,262	300,439	1,711,789	905,207
Maple sugar .... do....	9,937,276	....	17,276,054	20,556,049
Hay .... tons..	1,962,236	2,240,356	3,886,990	5,055,810

NOTE.—The returns of 1871 and 1861 are for the Provinces of Ontario, Quebec, New Brunswick, Nova Scotia, and Prince Edward Island, and those of 1851 for the first four provinces only.

AGRICULTURAL STATISTICS OF GREAT BRITAIN.

Area under crops in the United Kingdom.

Crops, &c.	Great Britain.		Ireland.		‡United Kingdom.	
	1884.	1883.	1884.	1883.	1884.	1883.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
Total area under crops	32,465,861	32,385,085	15,242,837	15,151,230	47,840,977	47,667,274
Wheat	2,677,035	2,613,162	69,008	94,802	2,750,588	2,713,282
Barley	2,168,820	2,291,991	167,346	184,015	2,346,041	2,486,137
Oats	2,915,363	2,975,381	1,347,895	1,880,871	4,276,806	4,870,076
Rye	47,040	50,768	7,152	7,250	54,234	58,082
Beans	446,824	447,934	7,756	10,250	454,839	458,440
Peas	229,645	239,439	972	937	230,696	240,501
Total corn crops	8,484,730	8,618,675	1,599,639	1,678,125	10,118,264	10,326,518
Potatoes	565,048	543,455	798,942	806,664	1,373,835	1,350,726
Turnips and swedes	2,027,6'0	2,028,926	304,031	806,767	2,342,577	2,346,216
Mangold	327,364	320,937	*34,512	*37,908	363,031	368,811
Carrots	18,587	13,338	†3,130	†3,436	17,062	17,184
Cabbage, &c	146,946	146,102	45,346	41,489	192,397	187,685
Vetches, &c	407,148	392,821	35,443	33,989	444,958	429,313
Total green crops	3,487,703	3,454,579	1,221,418	1,280,258	4,733,860	4,708,934
Clover and grasses	4,381,404	4,395,922	1,962,730	1,931,101	6,392,402	6,371,799
Permanent pasture	15,290,820	15,065,373	10,346,308	10,191,118	25,667,206	25,2[illegible]8,520
Flax	2,247	4,317	89,197	95,935	91,444	100,262
Hops	69,258	68,016	....	....	69,259	68,016
Bare fallow	749,699	778,203	23,560	24,698	773,542	803,225
Total acreage	20,493,428	20,311,831	12,421,795	12,242,852	32,993,853	32,631,822

* Including beet-root. † Including parsnips. ‡ Including the Isle of Man and Channel Islands.

Farm animals of the United Kingdom.

Description.	Great Britain.		Ireland.		†United Kingdom.	
	1884.	1883.	1884.	1883.	1884.	1883.
	Number.	*Number.*	*Number.*	*Number.*	*Number.*	*Number.*
Horses:						
Used in agriculture	990,490	905,073	480,846	478,912	1,904,515	1,8[illegible],7[illegible]
Mares and unbroken horses	423,887	415,523				
Total horses	1,414,377	1,410,596	480,846	478,912	1,904,515	1,8[illegible],7[illegible]
Cattle:						
Milch cows	2,390,863	2,306,082	1,356,455	1,401,672	3,764,903	3,72[illegible]
Other cattle	3,878,278	3,656,697	2,755,812	2,694,349	6,657,859	6,87[illegible]
Total cattle	6,260,141	5,962,779	4,112,267	4,096,021	10,422,762	10,[illegible]
Sheep:						
One year old	16,384,863	15,948,667	2,027,072	1,984,612	18,448,186	17[illegible]
Under one year old	9,683,491	9,119,604	1,216,500	1,234,486	10,928,601	1[illegible]
Total sheep	26,068,354	25,068,271	3,243,572	3,219,098	29,376,787	[illegible]
Pigs*	2,584,391	2,617,757	1,306,195	1,351,990	3,906,205	3,[illegible]
Poultry:*						
Turkeys	500,770	....	706,567	796,187	1,210,343	....
Geese	888,313	....	1,883,518	2,052,372	2,788,237	....
Ducks	2,368,390	....	2,618,530	2,836,847	5,006,711	....
Fowls	12,303.539	....	7,537,433	7,697,024	19,943,958	....
Total poultry	16,061,012	....	12,746,048	13,382,430	28,944,249	....

* With the exception of those for Ireland, the numbers of pigs and poultry are exclusive of those kept in towns, and by cottagers with less than a quarter of an acre of land.
† Including the Isle of Man and the Channel Islands.

AUSTRALASIAN STATISTICS.

WHEAT, 1883-'84.

Colony.	Area under wheat.	Gross wheat yield.	Average per acre.	Population December 31, 1882.
	Acres.	*Bushels.*	*Bushels.*	
Victoria	1,084,341	15,064,438	13.89	[illegible]
South Australia	1,846,175	14,649,230	7.83	[illegible]
New Zealand	377,706	9,827,136	26.02	517,7[illegible]
New South Wales	290,000	4,345,000	14.98	[illegible]
Tasmania	41,301	732,718	17.74	[illegible]
Western Australia	22,718	249,900	11.00	[illegible]
Queensland	10,494	145,752	13.89	[illegible]
Total 1883-'84	3,672,735	45,014,174	12.26	2,[illegible]
Total 1882-'83	3,434,005	31,763,098	9.25	....
Increase 1883-'84	238,730	13,251,076	3.01	....

.OATS, BARLEY, AND POTATOES, 1883-'84.

Colony.	Oats.		Barley.		Potatoes.	
	Acres.	Bushels.	Acres.	Bushels.	Acres.	Tons.
Victoria	188,161	4,717,624	46,833	1,069,808	40,195	161,[illegible]
South Australia	5,491	80,467	13,475	187,806	6,603	[illegible]
New Zealand	262,954	9,231,339	32,907	964,456	21,102	[illegible]
New South Wales*	24,818	617,465	6,473	133,050	14,462	[illegible]
Tasmania	23,160	634,354	8,205	81,962	9,601	[illegible]
Western Australia	1,395	23,715	5,548	88,768	310	[illegible]
Queensland	125	1,112	241	3,190	5,468	14,[illegible]
Total	506,104	15,306,076	108,681	2,520,035	97,201	[illegible]

*For 1882.

RAILROAD AND TELAGRAPH MILEAGE.

The following is an official statement of the mileage of railways and telegraph lines in the colonial possessions of Great Britain in 1883:

Colony.	Railways.	Telegraphs.
Australasia:	*Miles.*	*Miles.*
New South Wales*	1,268	9,013
Victoria	1,562	3,660
South Australia	991	5,278
Western Australia	95	1,585
Tasmania	167	†1,273
New Zealand	1,389	4,074
Queensland	1,038	6,654
Total Australasia	6,510	31,537
India	‡10,832	21,740
Ceylon	178	1,093
Mauritius	92	....
Natal	98½	....
Cape of Good Hope	§1,213	4,031
Dominion of Canada	8,805	....
Jamaica	25	....
Trinidad	43½	....
British Guiana	21	....

* For 1882.
† And 46 miles telephone.
‡ March 31, 1884.
§ Exclusive of 133 miles private line.

PRODUCTION OF WINE IN FRANCE.

Years.	Area.	Production.	Import.	Export.
	Hectares.	*Hectoliters.*	*Hectoliters.*	*Hectoliters.*
1873	2,380,946	35,716,000	654,000	3,981,000
1874	2,446,862	63,146,000	681,000	3,232,000
1875	2,421,247	83,836,000	292,000	3,731,000
1876	2,369,834	41,847,000	676,000	3,331,000
1877	2,346,497	56,405,000	707,000	3,102,000
1878	2,295,980	48,729,000	1,603,000	2,795,000
1879	2,241,477	25,770,000	2,938,000	3,047,000
1880	2,204,459	29,667,000	7,219,000	2,488,000
1881	2,699,923	34,139,000	7,839,000	2,572,000
1882	2,135,349	30,886,000	7,537,000	2,618,000
1883	2,121,595	44,570,000	8,980,000	2,547,000
Average	2,333,078	45,010,000	3,556,000	3,040,000

WHEAT PRODUCTION IN INDIA.

The increase of exports from India, from a few hundred thousand bushels per annum, ten to twenty years ago, to 37,148,543 bushels in 1881–'82, and 39,127,977 bushels of 60 pounds for 1883–'84 (year ended March 31), has excited the attention of the wheat-growing countries. It is known that India comes near to France and Russia in the volume of wheat production, and that these countries have only one outranking competitor—the United States of America. Conditions have not been favorable in former years for large India exports, mainly from lack of transportation facilities, having only one mile of railway for

every 25,000 people, while this country has a mile for less than 500 inhabitants. The careless cleaning of the grain and the mixing of the different kinds, diverse in quality, has also tended to keep the price too low for active supply for exportation.

It is now proposed to increase India railway facilities, and the home government is asked to assist in the extension. Mr. W. W. Hunter, of the viceroy's legislative council, laid before a committee of the British Parliament, in June last, a plan for building 7,328 miles, of which 3,896 are deemed indispensable for providing relief in case of threatened famine, while the remaining 3,432 are held to be desirable if individuals are willing to build with the aid of a proffered right of way and land for stations. Five years are allowed for the completion of the 3,896 miles, at a cost of £28,250,000, requiring an expenditure of over five and a half millions sterling per annum.

Mr. Hunter also stated before the committee, that as a result of a series of experiments and investigations in India, wheat could be produced, with hired labor under good supervision, at about 12*s.* a quarter, or 1*s.* 6*d.* (about 36½ cents) per imperial bushel. The imperial bushel is very slightly larger than our Winchester bushel. He declared that wheat had certainly been sold at profit at 16*s.* to 18*s.* per quarter (48⅔ to 54¾ cents per bushel).

LAND AREAS OF INDIA.

The following tables on the areas of the different presidencies and provinces of British India, with the area of cultivated, culturable, and unculturable land, and the area under the principal crops, are taken from the fifteenth number of the Statistical Abstract for British India, an official publication for which these tables, with others on Indian agriculture, were condensed from the administration reports and land-revenue returns of the different Indian governments and administrations. The tables are prefaced by a statement that the information they contain is far from complete. In the year to which they relate—the official year 1878–'79—the total area under British administration in India was about 904,000 square miles, while the native states comprised an area of 575,000, making a total of 1,479,000 square miles. The sum of the areas given in the column on the areas of the different presidencies and provinces in the table immediately below is 670,536 square miles, or a little less than three-fourths of the area of British India, and considerably less than one-half of the whole country. The portions of British India which are omitted include Bengal, comprising 156,000 square miles, for which no information of the kind given below is collected. In the case of Bombay, the Northwestern Provinces, and Oudh, the figures in the column headed "Area unculturable" embrace a considerable amount of land which should more properly have appeared under the head of "Cultivated area." The reason given for their being thus misplaced is that, being wholly or partially free from assessment to land revenue, no information was received as to their cultivation, notwithstanding the fact that in large part they were really cultivated. With these explanations the first of the tables referred to is presented:

Table showing the areas of the different presidencies and provinces of British India, and the areas of cultivated, culturable, and unculturable land, as far as could be ascertained, for the official year 1878-'79.

Presidency or province.	Total area of each presidency or province, as given by surveyor general.	Area cultivated.	Waste lands.	
			Area culturable.	Area unculturable.
	Square miles.	*Square miles.*	*Square miles.*	*Square miles.*
Bengal*	......	......	......	......
Assam	*a* 32, 826	*a* 7, 531	*a* 18, 823	*a* 6, 472
Northwestern Provinces	81, 775	*b* 38, 070	13, 837	29, 868
Oudh	23, 256	*b* 12, 930	6, 302	4, 024
Punjab	107, 010	36, 656	36, 706	33, 648
Central Provinces	84, 208	22, 840	26, 755	34, 613
British Burmah	87, 470	4, 978	37, 479	45, 013
Berar	17, 711	*c* 11, 162	2, 273	4, 276
Mysore	20, 633	*c* 7, 903	5, 108	16, 622
Madras	*d* 86, 439	31, 056	30, 764	*e* 24, 619
Bombay	*f* 73, 609	*b c* 35, 053	4, 022	84, 534
Sind	46, 609	4, 183	(†)	(†)
Total embraced in returns	670, 536	212, 362	182, 069	233, 689

*No information for this presidency.
† No information.
a Exclusive of the Garo and Noga Hills.
b Includes assessed lands only; lands exempt from assessment are included in the fourth column of figures.
c Includes fallow, pasture, and meadow lands.
d Exclusive of the Madras district and of the area of the Zemindary or permanently settled lands, comprising 58,498 square miles.
e Includes culturable and pasture lands in Malabar, which cannot be separately stated.
f Excluding the district of Kanara and the collectorate of Bombay.

Table showing the area (actual or approximate) under different crops in each presidency or province of British India, for the year 1878-'79.

Presidency or province.	Total cultivated area as given in second column of preceding table.*	Rice.	Wheat.	Other food grains, including pulses.	Sugar-cane.	Cotton.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
Bengal†	......	......	......	......	......	......
Assam	4, 810, 840	3, 110, 137	21, 675	378, 511	65, 644	40, 015
Northwestern Provinces	24, 364, 800	(‡)	4, 958, 200	17, 308, 500	(‡)	(‡)
Oudh	8, 275, 200	1, 099, 233	1, 701, 143	5, 164, 702	140, 033	40, 680
Punjab	23, 459, 840	623, 963	6, 909, 702	10, 438, 723	412, 879	785, 428
Central Provinces	14, 617, 600	3, 918, 837	3, 143, 302	5, 546, 447	93, 927	724, 306
British Burmah	3, 185, 920	2, 707, 755	1, 608	9, 947	4, 265	9, 496
Berar	4, 143, 680	27, 604	612, 236	2, 807, 343	120, 031	2, 207, 889
Mysore	5, 057, 920	643, 119	13, 853	3, 265, 099	16, 602	21, 043
Madras	19, 877, 127	5, 305, 804	17, 090	12, 696, 540	50, 835	1, 022, 553
Bombay	22, 483, 208	1, 174, 948	1, 026, 179	13, 224, 066	40, 215	1, 378, 622
Sind	2, 678, 061	526, 485	407, 399	1, 393, 934	3, 722	59, 745
Total (excluding Bengal)	135, 913, 196	19, 137, 885	18, 812, 407	72, 233, 872	957, 253	6, 296, 777

*The figures for Madras, Bombay, and Sind, given in the first column of this table, when reduced to square miles for comparison with the corresponding figures in the second column of the preceding one, differ slightly from the latter; but the largest difference—that in the case of Madras—amounts only to 2 square miles and 7 acres.
† No information respecting this province.
‡ Not separately reported.

NOTE.—In addition to the crops embraced in the table there were oil-seeds occupying an aggregate area of 5,148,490 acres; fiber-yielding plants, other than cotton, occupying 283,833 acres; indigo, cultivated chiefly in Madras and the Punjab, occupying 277,793 acres; coffee and tea, occupying 287,568 acres; tobacco, occupying 399,164 acres, and miscellaneous crops, aggregating 3,187,209 acres. Tobacco is very generally cultivated, but most largely in Madras, Punjab, Bombay, and the central Provinces. Of the area reported as occupied with coffee and tea all but about 4,000 acres in Madras is occupied with the former, the bulk of which is grown in Assam, Mysore, and Madras. It will be remembered that there are no returns for Bengal.

AREA IN WHEAT.

A recent paper published by the Indian Government giving results of an investigation made at the request of the secretary of state for India, makes the following estimates:

	Acres.
Bengal (Behar)	850,[illegible]
Northwestern Provinces and Oudh	6,200
Punjab	7,000
Central Provinces	4,00[illegible]
Bombay	1,60[illegible]
Berar	700
British India (excluding Madras, Burmah, Assam, Mysore, and Sind).	

Native states:	Acres.	
Hyderabad	750,000	
Central India agency	2,500,000	
Rajputana agency	2,500,000	
Baroda	88,000	
Total for native states		5,[illegible]
Total for India (except omitted states and provinces)		26,1[illegible]

The provinces of British India omitted from the above statement were reported in the preceding table for 1878–'79 as having the following areas in wheat:

Assam	21,675
British Burmah	1,608
Mysore	13,853
Madras	17,099
Sind	407,399
Total for omitted provinces of British India	461,685

PRODUCT AND YIELD.

Sir Evelyn Baring has estimated the yield per average acre at 700 pounds, or 11⅔ bushels of 60 pounds. Others make a lower average of yield. It is a matter of much doubt whether the real average is more than 11 bushels. Dr. Watson estimated the product of wheat grown under British rule at 240,000,000 to 280,000,000 bushels, and including the native states in the Punjab, Rajputana, Malwa, Bundelkund, and Guzerat, he placed India above France and Russia, and next to the United States, in wheat production. But the recent investigation above referred to does not sustain these high estimates. With proper regard to "the widely varying skill, energy, and resources of the cultivator," the land in each province is divided into three classes, viz:

Class I, embracing lands of average good quality, manured and irrigated.

Class II, embracing lands of fairly good quality, and of which the cultivation is so far careful that it includes either manuring or artificial watering.

Class III, embracing lands of an inferior quality and lands which from some cause or other are inefficiently or carelessly cultivated.

The following statement shows the estimated yield per acre on land of each class and the estimated average for each of the presidencies and provinces named, the average having been estimated in each case with due regard to the estimated proportion between the different classes of land:

Estimated yield of wheat per acre.

Provinces.	Class I.	Class II.	Class III.	Average.
Punjab........bushels..	20	11	7½	10
Northwest Provinces and Oudh........do....	23	15	9	13
Bombay........do....	18	10	6	9
Central Provinces........do....	16	10	6	8
Berar........do....	12	8	5	7

The highest provincial average is assigned to the Northwest Provinces and Oudh, where "a greater area of land is believed to fall into the first category than in even the fertile plains and river valleys of the Punjab." In the Central Provinces the physical conditions are highly favorable, but the cultivation is inferior. "In Berar the best land is given up to cotton, and wheat is a secondary crop, to which comparatively little labor or care is given. In Bombay the yield of the richest lands in Guzerat is probably unsurpassed in India, but in the Deccan there is a large amount of poor land, which greatly reduces the average outrun of the presidency."

The estimate of total production based upon the areas and average yields above given is "between 5,500,000 and 6,000,000 tons for British India, and 1,250,000 tons for the native states, making a total of between 6,750,000 and 7,250,000 tons for all India; or, taking the lower figure, 252,000,000 bushels of 60 pounds to the bushel." The distribution of this total may be approximately stated as follows:

	Bushels of 60 pounds.
Northwest Provinces and Oudh	80,600,000
Punjab	70,000,000
Central Provinces	32,000,000
Bombay	14,400,000
Berar	4,900,000
Other British provinces	3,433,334
Total for British India	205,333,334
Native states	46,666,666
Total for all India	252,000,000

Of this total it is roughly estimated in the document from which the above estimates are taken that about one-fourth may be available for export.

PROBABLE EXTENSION OF WHEAT CULTURE.

The lands of British India, now lying waste, but assumed to be culturable, are reported as 182,069 square miles in the preceding table; and of this area only 83,600 are found in wheat-growing provinces, mostly in the Punjab, Oudh, Northwestern, and Central Provinces. Should this area come into cultivation in the proportion of the present distribution of crops, it would add about twelve million acres, or a breadth somewhat larger than our own spring wheat area of the Northwest. Of course it would be possible to give a larger proportion to wheat. In a country so conservative as India, so slow in industrial progress, the requisite changes to produce such results, the improvement of implements of cultivation, selection of seed, care in preparing for market, and the extension of railway facilities, cannot be expected to occur very rapidly.

The country roads and bridges are poor, and the railroad mileage in

March, 1883, was only 10,251 miles open for traffic, which is the construction of a single year in the United States.

One point in the India question should not be forgotten. T increase in exportation is largely due to recent extensions of th system, and an enlargement of these facilities would render po receipt of much larger export supplies. In this connection it remember that wheat is not the food grain of the India popula therefore, the proportion available for export can be largely under the stimulus of high prices. Should railway charges be a similar result would follow. The following rates are quoted

Delhi to Howrah on the East India Railway, 954 miles	...
Lahore to Kurrachee, 821 miles	...
Delhi to Bombay, over the Rajputana Railway, 889 miles	...
Jubbulpore to Bombay, 616 miles	...

As compared with these rates, the average all-rail rate from to New York, 913 miles by the shortest practicable route, January 1 to November 1, 1883, 16.1 cents per bushel, or $6.01 The average of the four Indian rates was a little less than on mile per ton, as against less than two-thirds of a cent on the tween Chicago and New York. In other words, the averag four Indian rates is fully 50 per cent. higher than the rate on th ican lines between these two cities; while the advantage on of the United States is very much greater still, if the Indian compared with our rates by lake and canal, or even by lake a the former being but little more than one-third of a cent, and th being less than one-half a cent per ton per mile.*

Mr. Baring points out that America also has an advantage ov in other particulars connected with the movement of the grai sea-board. He says:

> There is far less handling of the wheat between the fields and the hold of in the former than in the latter country. The wheat is brought from the storehouses, and thence shot in bulk into the wagons [freight cars], which brought alongside the ship or to warehouses which lie close to the ship. on the other hand, wheat is brought from the field to a central station, say C is there bought by one trader (perhaps the agent of the shipping firm, another intermediary) from another trader, who has bought it from the cu It is stored and bagged, then carted to a railway station, unloaded, stacke station, and again unstacked to be loaded into the wagons [freight cars]. O at the port of shipment it is unloaded, stored, perhaps bought and sold on then carted to the shore, and put on board either from a jetty or from a boa

The following figures in relation to the charges to which wheat ject in the course of transportation are obtained from a report State Department by United States Consul-General Mattson, cutta, dated December 23, 1882:

	P
From Punjab to Kurrachee, average distance 800 miles	...
From Northwest Provinces and Oudh to Calcutta, average distance 700 miles	
From Central Provinces to Bombay, average distance 460 miles	...
From province to city of Bombay, average distance 150 miles	...

To this cost must be added the charges of the middlemen at the inland bas will average 5 cents per bushel, and the cost of bagging, shipping, and comm the exporter at the sea-port 8 cents more; ditto, insurance and landing ch London 5 cents, and ocean freight, which averages from Calcutta to London and from Bombay and Kurrachee 35 cents.

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* During the season of 1884 the rates by rail from Chicago to New York w siderably lower than the above.

Projects for navigation by canals and for extension of irrigation works are also entertained as factors in the cheapening of wheat at the seaboard; for the movement of Indian wheat to Liverpool, as well as the shipment of Dakota wheat to the same mart, depends upon price. The country that will produce it for the least money will have the trade of Liverpool, and the internal improvements of India, projected and fostered in Great Britain, are so many levers employed to depress the prices of wheat throughout the world.

An official estimate of the average rate of yield per acre of irrigated land in the Northwest Provinces and Oudh is $20\frac{1}{2}$ buhsels, where on lands not irrigated it is $13\frac{3}{4}$ bushels. About two-fifths of the wheat area of these provinces is irrigated. The population of this region is over four hundred to the square mile, while the holdings range from an average of 3 to an average of $8\frac{3}{10}$ acres. The Central Provinces farms are much larger, the land is rich, and manure and irrigation not much used.

Mr. J. B. Fuller, assistant director of agriculture of the Northwest Provinces and Oudh, thus reports the mode of cultivation and harvesting, commencing with a description of the plow:

In its idea it may be considered a pickaxe, drawn by bullocks, the handle being the plow-beam, one arm of the pick the plowshare, and the other arm the handle or stilt. It, therefore, tears and does not cut the ground, and, weight for weight and depth for depth, is infinitely heavier to draw than the modern plows of Europe or America. It is, in fact, a grubber, not a plow, and merely stirs the earth without inverting it.

The plow is at its worst, as regards the Northwest Provinces and Oudh, in the rice districts of Oudh and the Benares division, where it is of ludicrously small size, often only weighing 17 or 18 pounds. * * * Speaking generally, the efficiency of the plow may be said to increase as we go westward, the ordinary plow of the Central Doab weighing about 28 pounds, while that of the Western Districts weighs nearly 50 pounds, is bound with iron round the edges of the sole, and, instead of a short spike for a share, has a long iron bar which projects behind and can be thrust forward from time to time as its point wears down.

In the drier districts of the Agra and Allahabad divisions and Bundelkhand wheat * * * is generally sown with either barley or gram, which by their superior hardiness continue to eke out a crop in cases where the wheat would fail from insufficient moisture. Wheat is * * * sown in the end of October or beginning of November, and cut in March and April. As a rule it is only sown on land which has lain fallow during the preceding *kharif* [summer], but in highly manured land near village sites it occasionally follows maize, the maize being cut only six or eight weeks at the most before the wheat is sown. * * *

Wheat is grown on almost every soil but the very lightest sand, a rather heavy loam being considered best suited to it. The fields of loamy soil, which cover a large part of the Doab, * * * bear, with careful cultivation, crops of wheat of surprising excellence, although unmanured for years. But manure is as a rule applied to the better class of wheat fields generally in every second or third year, although in quantities which would sound ridiculously small to the English farmer, 4 tons [to the acre] being about the average. It is reported from some districts of the provinces that land is occasionally prepared for wheat by herding sheep or cattle on it, but this is a practice of very far from general occurrence.

Twenty plowings are not uncommon in Gorakhpur, while two or three are held sufficient in the black soil of Bundelkhand. Eight plowings may be taken as the average number.

The clods are crushed and a fine tilth (which is absolutely essential in most soils) created by dragging a flat log of wood across the field, the bullock driver standing on it to increase its weight.

If the ground is very damp, the seed is sometimes sown broadcast and plowed in, * * * but the two commonest methods of sowing are (1) by simply following the plow and dropping the seed into the furrow made by it, * * * and (2) by dropping the seed down a bamboo tube fastened to the plow stilt [the former being the practice in some localities and the latter in others].

The amount of seed used per acre varies from 100 to 140 pounds. After the sowing is completed, the field is either left in furrow or is smoothed with the clod-crusher, the latter process being said to save irrigation by enabling the water to spread quicker over the surface. The field is then divided off into irrigation beds by scraping up little banks of earth with a wooden shovel.

If the soil is sufficiently moist in October, * * * the necessity of irrigation

depends in chief measure on the occurrence of winter rains. * * * Should the soil be too dry for germination, a watering must be given before sowing, and this—[illegible] comparatively easy matter in canal districts—occasions great labor and delay in [illegible] tricts which rely on wells for their water supply. [An instance is mentioned i[illegible] which nearly the whole of the usual crop of a district was sown on well water.] Th[illegible] number of waterings given to wheat varies from one in Rohilkhand, to seven [illegible] eight in the drier parts of the Doab, but as a rule three or four waterings are ampl[illegible] even in the driest localities.

The crop when ripe is cut by sickles and carried to the thrashing floor, where, aft[illegible] having been allowed to dry for several days, it is trodden out by bullocks and wi[illegible] nowed by the simple expedient of exposing the grain and chaff to the wind by pou[illegible] ing them out of a basket held some 5 feet from the ground. Should there be [illegible] wind, an artificial breeze is made by agitating a cloth, but this adds greatly to th[illegible] expense and trouble.

COST OF GROWING WHEAT.

Mr. Fuller gives "a near estimate of the cost of growing a[illegible] vesting an acre of wheat," as follows:

Appraising the whole of the labor applied to the field the following may be ac[illegible] cepted as a near estimate of the cost of growing and harvesting an acre of wheat:

Items.			Rupees.	Annas.	United States money.
Plowing (eight times)			6	0	[illegible]
Clod-crushing (four times)			0	8	[illegible]
Seed (100 pounds)			3	0	[illegible]
Sowing			0	14	[illegible]
Weeding			0	12	[illegible]
Reaping			1	8	[illegible]
Thrashing on a crop of 20 maunds, equal to 27 bushels*			†3	0	[illegible]
Cleaning on a crop of 20 maunds, equal to 27 bushels*			0	6	[illegible]
Total, excluding irrigation, manure, and rent			16	0	[illegible]
Irrigating (three times):					
Making water beds	0	3			
Canal dues	1	8			
Labor	3	12			
			5	7	[illegible]
Manure (100 maunds)			3	0	[illegible]
Rent (for second-class land)			7	0	[illegible]
Grand total			31	7	[illegible]

* Reckoning the maund at 82.2855 pounds avoirdupois and the bushel at 60 pounds, 20 maunds [illegible] more than 27.4 bushels. This is considerably more than the average product even for ir[illegible] the Northwest Provinces, but the figures as to cost are apparently based upon a rather [illegible] of cultivation from which a superior crop might fairly be expected.

† Two pairs of bullocks (at 3 annas, or 7.3 cents a pair) and two coolies (at 2 annas, or a fractio[illegible] than 5 cents each) tread out nearly 340 pounds of grain in a day.

This makes a cost of about 45 cents per bushel for the wheat [illegible] duced, which is much above the average yield even of irrigated [illegible]

An official document estimates the cost of growing wheat on [illegible] and irrigated land at a little under a shilling per bushel, or in[illegible] of rent, 1*s.* 6*d.*, or 36½ cents. This includes seed and thrashing. A[illegible] official report makes the following average prices [reducing [illegible] of quantity and value]:

Time.	1881.	1882.
	Cents.	Cents.
First quarter	[illegible]	[illegible]
Second quarter	[illegible]	[illegible]
Third quarter	[illegible]	[illegible]
Fourth quarter	[illegible]	[illegible]
Whole year	[illegible]	[illegible]

While the cost, under favorable circumstances and in the best locations, may be 35 to 40 cents per bushel, wheat can rarely be brought to the principal markets and sold for less than 60 cents. Consul-General Mattson, at Calcutta, makes report to the State Department that the ryot "can afford to sell his wheat at the nearest market place, if within a day's journey of his home, for 50 to 60 cents per bushel; but when it does not bring that price, or very near it, he consumes his small supply, or stores it in a hole under the ground until a more favorable time shall come."

The wheat of India is of less intrinsic value than that of the United States, partly from its "ricey" character, and partly from the dirty condition in which it is shipped. Yet the average difference is not great, as some of it is of good quality. The official valuation of exports in the period from 1878–'79 to 1882–'83 averaged 91½ cents. The average of our wheat exports for a like period was \$1.15. Mr. Baring states that Calcutta Club No. 1 averaged \$1.27 per bushel in 1882, while the best American brought \$1.44.

A British parliamentary report comprises prices per imperial quarter of several Indian and other wheats, as follows:

Wheat.	Value per 496 pounds.	Weight per bushel.
	s. d.	*Pounds.*
Indian (fine soft white)	49 0	64
Indian (superior soft red)	45 0	62¾
Indian (average hard white)	44 0	60
Indian (average hard red)	43 0	61½
English	49 0	60½
Australian	50 6	62½
New Zealand	48 0	62¾
California	48 0	59½
American (winter)	49 6	61¾
American (spring)	48 0	61
Russian (Saxonska)	52 0	60½
Russian (hard Taganrog)	49 0	61¼
Egyptian (Buhi)	47 0	58
Egyptian (Saida)	43 6	57½

EXPORTS AND IMPORTS.

The following table shows the exports of wheat and flour from British India and the United States, respectively,* during the five years from 1878–'79 to 1882–'83, inclusive, flour being reduced to its equivalent in wheat, and included with the latter:

Official years.	Wheat (including flour exported).	
	From India.	From the United States.
	Bushels.	*Bushels.*
1878–'79	2,012,151	147,687,649
1879–'80	4,172,541	180,304,180
1880–'81	13,901,382	186,321,514
1881–'82	37,195,846	121,892,389
1882–'83	26,559,404	147,811,316

* Of the totals given in the table, flour on an average for the five years, constituted nearly 20 per cent. in the case of the United States, as against less than two-thirds of 1 per cent. in the case of India.

The following tables show, by quantities and values, respectively, the distribution of the Indian export among the different countries to which it is shipped. It will be observed that during the earlier embraced in the tables, by far the greater part of the entire a exported was taken by the United Kingdom, but that within t few years the proportion taken by other countries, particul France, Holland, and Belgium, has materially increased, leaving United Kingdom, in the years 1881–'82 and 1882–'83 somewhat l one-half of the total. It is stated that the shipments to Egypt, appear in these latter years, are chiefly destined for transshi markets on the continent of Europe.

Table showing by countries the quantities of wheat of domestic production exported from British India during the years from 1876–'77 to 1882–'83, inclusive.

QUANTITIES.

Countries to which exported.	1876–'77.	1877–'78.	1878–'79.	1879–'80.	1880–'81.	1881–'82.	1882–'83.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
United Kingdom	8, 096, 122	10, 698, 518	1, 597, 273	3, 037, 022	8, 964, 168	17, 507, 907	[illegible]
Austria	3, 860	1, 063	....	....	6, 348	53, 052	
Belgium	310, 472	14, 930	....	56, 509	422, 158	4, 900, 423	[illegible]
France	1, 047, 769	217, 792	20, 556	138, 439	2, 513, 933	9, 908, 403	[illegible]
Holland	....	....	....	....	681, 995	1, 329, 795	[illegible]
Italy	123, 051	45, 035	....	47, 744	254, 848	670, 727	
Malta	358, 178	78, 351	....	....	115, 539	201, 006	
Egypt	....	196, 403	....	....	....	1, 715, 534	[illegible]
Reunion	78, 014	48, 733	92, 684	75, 562	67, 583	72, 824	
Mauritius	191, 983	289, 124	82, 867	57, 280	147, 078	116, 996	[illegible]
Aden	24, 785	48, 877	40, 199	55, 147	89, 514	65, 609	
Arabia	5, 206	13, 328	2, 305	123, 219	198, 362	181, 899	
Ceylon	41, 701	50, 385	31, 843	21, 033	24, 625	109, 485	
Turkey in Asia	....	....	....	881, 119	204, 114	....	....
Persia	....	17	125	52, 982	145, 563	685	....
Straits Settlements	80, 644	54, 146	38, 925	36, 387	38, 597	25, 009	
Other countries	51, 442	77, 644	43, 346	15, 827	21, 746	219, 217	
Total	10, 442, 227	11, 834, 946	1, 950, 123	4, 098, 360	13, 896, 166	37, 078, 571	

VALUES.

Countries to which exported.	1876–'77.	1877–'78.	1878–'79.	1879–'80.	1880–'81.	1881–'82.	1882–'83.
United Kingdom (Great Britain)	$5, 907, 696	$10, 293, 299	$1, 636, 338	$3, 218, 504	$8, 183, 097	$15, 862, 572	
Austria	4, 724	1, 569	....	....	6, 083	48, [illegible]	
Belgium	260, 513	17, 062	....	71, 600	430, 483	4, 705, [illegible]	[illegible]
France	885, 766	215, 770	22, 416	155, 046	2, 566, 242	9, 555, [illegible]	[illegible]
Holland	....	....	....	....	560, 897	1, 072, 684	
Italy	123, 245	43, 712	....	58, 281	275, 326	670, 854	[illegible]
Malta	270, 559	84, 861	....	....	107, 679	203, 823	
Egypt	....	169, 222	....	....	....	1, 543, 152	[illegible]
Reunion	56, 754	50, 940	106, 016	88, 140	64, 176	63, 750	
Mauritius	145, 489	276, 734	89, 916	62, 300	148, 106	100, 033	
Aden	24, 606	60, 868	53, 537	72, 473	97, 758	63, 532	
Arabia	4, 518	18, 870	2, 734	146, 970	207, 374	182, 958	
Ceylon	42, 466	67, 364	48, 196	32, 190	28, 964	97, 022	
Turkey in Asia	....	....	....	455, 012	223, 498	....	....
Persia	....	17	152	62, 532	147, 608	652	....
Straits Settlements	59, 674	50, 210	42, 058	39, 435	33, 946	20, 381	[illegible]
Other countries	39, 320	82, 055	53, 751	21, 576	21, 529	224, 110	[illegible]
Total	7, 825, 330	11, 427, 559	2, 055, 114	4, 484, 059	13, 111, 766	34, 416, [illegible]	[illegible]

YIELD OF FIELD CROPS IN RUSSIA.

The following data in relation to the yield of some of the principal field crops in Russia are taken from a report on "The Year 1883 in its Relation to Rural Economy," recently published by the Russian Government. In the tables which follow, the rate of produce per desiatine is expressed for the cereals and potatoes in chetverts, and for sugar beets in berkovets, the desiatine being an area equal to 2.86 acres,* the chetvert a measure equal to very nearly six Winchester bushels (more precisely 5.956), and the berkovet of ten poods a weight equivalent to 361.13 pounds avoirdupois.

The most general division noted in the tables is that which distinguishes the Blackearth region from other portions of European Russia. This region extends in a broad belt across the southern part of the country from the Roumanian and Austrian frontiers to the eastern boundary, embracing the alluvial valleys of the great rivers which flow into the Black Sea, the Sea of Azof, and the Caspian, and extending farthest to the northward in the valley of the Volga. In this Blackearth region are embraced the districts which produce the largest quantities of grain for exportation, including the great wheat-producing governments of Podolia, Kiev, Voronej, and Kursk.

The largest average yield of winter wheat in the year 1883, as shown by the figures given below, was in the governments of Tula, Orel, Riazan, and Tambov in the northern portion of the Blackearth region, and outside of this region in the Baltic provinces (Livonia, Courland, and Esthonia), the government of Pskov, east of Livonia, the government of Kovno, south of Courland, the valley of the Vistula in Poland, and the governments of Smolensk and Kaluga, southwest of Moscow. In these governments the average was from six to nine chetverts per desiatine, or from 12½ to 18¾ bushels per acre, the latter being the average for Livonia and Pskov. These figures relate to the yield on the lands of the larger proprietors, those of the peasants, as will be seen by the table, being in general considerably less productive. In the other governments for which an average is given it ranges from 11½ bushels in Kiev, Voronej, Vitebsk, and Mohilev down to 3⅛ bushels in Ekaterinoslav, and on peasants' lands still lower, the average on such lands in the last named government being as low as 2.1 bushels per acre.

For spring wheat the highest averages of the Blackearth region are in the governments of Tambov (northern division), and Kazan, Simbirsk, Samara, Ufa, and Saratov (eastern and southeastern division). In the non-Blackearth region the highest averages are in the Baltic provinces, the adjoining government of Kovno, and the governments of Smolensk, Novgorod, Jaroslav, and Vologda. In all of these governments the average is 12½ bushels per acre or more, the highest being 16⅝ bushels in Livonia. The lowest average is 6¼ bushels on proprietors' land and 5¼ on peasants' land, these being the respective rates of yield on these two classes of land in Ekaterinoslav and Taurida, while in Volhynia the rate is 6¼ bushels on both classes of land alike. In other provinces the figures lie between the extremes just given.

The averages for winter rye range from 18¾ down to a little more than 3⅛ bushels on proprietors' land, and from 15⅝ down to 2½ on peasants' land. The yield of this grain for the year was generally good, except in the eastern and southeastern division of the Blackearth region, and in Volhynia in the western part of the same region. Elsewhere the average for proprietors' land ranges between 8⅛ and 18¾ bushels, the

*Prof. F. W. Clarke makes the desiatine 2.6997 acres.

bushels per acre on proprietors' lands, and from 146 down to 16⅔ bushels on peasants' lands. The lowest averages are reported from the re-
on around the sea of Azov, embracing Taurida, Ekaterinoslav, and
e province of the Don Cossacks.

Of grains not embraced in the tables reproduced below, one of the
widely cultivated is buckwheat, for which averages are shown
ging from 17⅔ bushels per acre in Perm down to 1 bushel per acre
in Ekaterinoslav.

Millet, which is grown extensively in the Blackearth region, shows average yields ranging from 15½ bushels per acre in Tambov down to 2 bushels (on peasant lands) in Taurida and Ekaterinoslav.

Peas, which are very widely cultivated, show averages ranging from 16⅔ bushels per acre in Livonia and Smolensk down to 3 bushels (on peasants' lands) in Ekaterinoslav.

Of flaxseed the average yields range from 631 pounds to the acre in Tambov down to 101 pounds in Kherson, on proprietors' lands, and from 568 pounds in Saratov to 88 pounds in Kherson, on peasants' lands. Of flax fiber, the averages range from 379 pounds per acre in Smolensk down to 126 pounds in Viatka, on proprietors' lands, and on peasants' lands from 354 pounds in Kaluga down to 101 pounds in Perm.

Of hemp fiber, the average yields range from 505 pounds per acre in Smolensk down to 152 pounds in Kursk.

Of tobacco, which is more or less cultivated in most of the governments of the Blackearth region, the average yields range from 1,187 pounds per acre in Tshernigov down to 442 pounds in Taurida.

TABLES SHOWING THE YIELD OF CEREALS, SUGAR BEETS, AND POTATOES IN RUSSIA FOR 1883.

[1 desiatine=2.86 acres; 1 chetvert=5.956 Winchester bushels; 1 berkovet=361.13 pounds.]

TABLE I.—*Yield of field plants in Russia.*

[In chetverts.]

Governments.	Average per desiatine and range from minimum to maximum.											
	Winter wheat on lands of—				Spring wheat on lands of—				Winter rye on lands of—			
	Proprietors.		Peasants.		Proprietors.		Peasants.		Proprietors.		Peasants.	
	Av.	Range.	Av.	Range.	Av.	Range.	Av.	Range.	Av.	Range.	Av.	Range.
A.—BLACKEARTH REGION.												
I.—Southern Steppes:												
Bessarabia	5	1 - 8	4	1 - 7	4	1 - 6	3	1 - 6	6	2 -12	5	2 - 9
Kherson	4	0 -10	3½	0 -10	3½	1 -10	3	1 - 7½	5	1 -18	4½	0 -11
Ekaterinoslav	1½	0 - 5	1	0 - 8	3	1 - 9	2½	0 -10	4½	0 -18	3½	0 -11
Taurida	5	1 -12	4	½- 9	3	1 - 9	2½	1½- 9	5	2½- 8	4	1 - 6
Province of Don Cossacks	2	0 - 4	2	0 - 5	5	3 -12	4	2 - 8	4	0 - 7	3½	0 -12
II.—Central:												
Voronej	5½	1 -14	4½	0 -15	4½	1½-10	4	1½-10	6½	3½-13	5½	½-13
Kharkov	3½	0 -10	3	0 - 9	4	0 -11	3½	0 - 7	7	2½-15	5½	1 -11½
Poltava	4½	1 -13	4	1½-10	4	2 -10	3½	2 -10	6	2 -15	5½	1 -11½
III.—Southwestern:												
Kiev	5½	2½-15	4½	1½-12	4½	1½- 8	3½	3 - 4	6	2 -16	5½	2 -11½
Podolia	3½	1 - 8	3	1 - 8	3½	1½- 5	3	2½- 5	5½	2 -12	4½	1½-10
Volhynia	3½	1 - 7¼	3	1 - 7	3	¼- 5½	3	¼ -5	3½	¼-10½	2½	¼- 4½

TABLE II.—*Yield of field plants in Russia.*

In chetverts.

Governments.	Average per desiatine and range from minimum to maximum.											
	Spring rye on lands of—				Spelt on lands of—				Barley on lands of—			
	Proprietors.		Peasants.		Proprietors.		Peasants.		Proprietors.		Peasants.	
	Av.	Range.	Av.	Range.	Av.	Range.	Av.	Range.	Av.	Range.	Av.	Range.
A.—BLACKEARTH REGION.												
I.—Southern Steppes:												
Bessarabia	....	2	....	2 - 4	....	....	....	6	7½	4 -12	6½	3 - 8
Kherson	....	3 - 4	....	3	....	6 -15	....	3 - 3	6½	4 -18	5½	3 -15
Ekaterinoslav	....	2½- 6	....	....	....	0 - 6	....	....	5	0 -12	4½	0 -10
Taurida	....	....	....	3	....	3 - 3	....	....	6½	3 -12	5½	3 - 9
Province of Don Cossacks	....	....	....	....	....	....	....	....	6	2 -14	5½	2 -10
II.—Central:												
Voronej	....	3½- 6	....	2 - 3	....	....	....	....	6½	2½-15	4	2 -10
Kharkov	....	3 - 7	....	2 - 6	....	2 -10	....	....	6	0 -14½	5	1 -10
Poltava	....	3 - 8	....	3 - 4	....	10	....	....	5½	2 -11½	5	2 -10
III.—Southwestern:												
Kiev	4½	1 - 8½	....	1	....	....	....	....	6	2 -22	5	2 -16
Podolia	....	1½	....	....	....	....	....	....	4	½- 8	3½	½- 7
Volhynia	2½	½- 7½	....	3	....	....	....	....	4½	¾-11	4	¾-11
IV.—Northern:												
Kursk	....	6	....	....	....	5	....	....	7	1 -15	6	1 -12
Tshernigov	....	2 - 3	....	2	....	3 -10	....	....	6½	½-17	7	½-17
Orlov (Orel)	....	3½- 9	....	....	....	....	....	....	6½	0 - 8	5½	0 - 7
Tambov	....	3½	....	....	....	....	....	....	8½	2 -12	6½	4 -10
Tula	....	....	....	....	....	....	....	....	....	½ - 7	....	3 - 7½
Riazan	....	4½	....	....	....	....	....	....	....	....	....	5
Penza	....	5	....	....	....	5 - 5½	....	5½- 6	....	5 - 8	....	....
V.—Eastern and Southeastern:												
Kazan	....	....	....	....	9	4½-14	7	3 -15	9	4 -16	7	2½-11
Simbirsk	....	....	....	....	10	3 -17	8½	3 -17	9	5 -12	8½	5 -11
Samara	....	....	....	....	....	20 -23	....	17	8	3 -13	6½	2 -12
Orenburg	....	2 - 3	....	2 - 3½	....	....	....	1 - 4	....	0 - 3	....	½- 4
Ufa	....	....	....	....	7½	2½-16	7½	2½-14	....	2 -15	....	4½-12
Saratov	....	7	....	....	10	4 -19	9	4 -15	12	6 -20	10	3 -15½
Astrakhan	....	....	....	....	....	....	....	....	....	....	....	....
Ural Province	....	....	....	....	....	....	....	....	....	....	....	....
B.—NON-BLACKEARTH REGION.												
Moscow	....	....	....	....	....	....	....	....	6½	2 -15	6	1 -12
Tver	7	3 -15	....	6	....	....	....	....	9	2 -15	7	3 -15
Smolensk	....	8 -15	....	8 -15	....	....	....	....	6½	2 -20	5½	1½-12
Kaluga	....	4 - 6	....	....	....	....	....	....	7	1 -12	6½	1 -10
Vladimir	....	1 - 2	....	1 - 2	....	....	....	....	6	2 -10	5½	2 -10
Yaroslav	....	4 -12	8	5 -12	....	....	....	....	10	3 -14	8	3 -13
II.—Western:												
Kovno	....	....	....	....	....	....	....	....	8½	4 -15	6½	4 -12
Vilna	....	....	....	....	....	....	....	....	6	2 -15	5½	2½-13
Grodno	....	....	....	....	....	....	....	....	4½	1½-16	4	2 -15
Vitebsk	3	2 - 4	3	2 - 5	....	....	....	....	7	2 -20	6	1½-13½
Minsk	2½	1 - 4½	2½	1½- 5	....	....	....	....	5	2½-10	5	2 -11
Mohilev	4½	2 - 7	4	2 - 5	....	....	....	....	5½	2 -12	4½	2 -14
III.—Near the Vistula	5	2 - 8	5	2 - 8	....	3½- 7½	....	3 - 7½	7	3½-14½	6½	3 -12
IV.—Near the Baltic:												
Livonia	....	6 - 8	....	4 - 6	....	....	....	....	9	2 -15	8	4 -15
Courland	....	6 - 9	....	6 -10	....	....	....	....	8	2½-16	6	3 -15
Esthonia	....	....	....	....	....	....	....	....	9½	5 -14	8	3 -12
V.—Northwestern:												
Pskov	5½	3 - 7	4	3 - 5	....	....	....	....	8½	4 -14	7	4 -10
St. Petersburg	....	5 - 7	....	4½- 7	....	....	....	....	8	5 -20	6½	2½-10
Novgorod	....	½- 5½	....	3 - 5	....	5 - 9	....	....	7½	2 -15	6½	1½-15
VI.—Central Volgian and Trans-Volgian:												
Kostroma	....	....	....	4	....	....	....	5	8	4 -12	6	1½-15
Nizhni-Novgorod	....	3	....	2 - 4	7	6 - 9	9	6 -12	4	1 - 8	4	0 - 9
Viatka	....	3½-11½	....	3 - 9	5½	5 - 7½	5	3 - 6½	6	2 -14	5	1 -12
Perm	3½	3 -10	3	0 -10	....	5½-12½	....	2 - 7½	6½	2 -11	6	1 -11
VII.—Northern:												
Vologda	....	....	....	....	....	....	....	....	9	3 -18	9	3 -18
Olonetz	....	8	....	4 - 9	....	....	....	....	7	6 -10	6	3 -10
Archangel	....	4 - 5½	....	....	....	....	....	....	9	2 -21	7	2 -12

TABLE III.—*Yield of field plants in Russia.*

[In chetverts.]

Governments.	Average per desiatine, and range from minimum to maximum.											
	Oats on lands of—				Maize on lands of—		Sugar beets on lands of—		Potatoes on lands of—			
	Proprietors.		Peasants.		Proprietors.		Proprietors.		Proprietors.		Peasants.	
	Av.	Range.	Av.	Range.	Av.	Range.	Av.	Range.	Av.	Range.	Av.	Range.
A.—BLACKEARTH REGION.												
I.—Southern Steppes:												
Bessarabia	10	3 – 23	7	3 – 16	9	3 – 18	....	....	25	6 – 40	20	3– 5[illegible]
Kherson	8	3 – 30	6	2½– 20	6	0 – 14	....	67–125	20	2 – 80	15	3– 5[illegible]
Ekaterinoslav	6½	2 – 18	5½	0 – 15	3	0 – 9	....	40– 50	14	0 – 60	12	0– [illegible]
Taurida	6½	2 – 13½	6	1½– 10	4½	1 – 8	....	....	11	5 – 40	8	6– 1[illegible]
Prov. of Don Cossacks	7½	2 – 30	6½	2 – 15	....	2½	....	....	10	2½– 50	8	3– [illegible]
II.—Central:												
Voronej	12	4 – 22	10	4 – 22	6	1½– 18	70	20– 80	40	7 –102	35	10– 8[illegible]
Kharkov	10	2 – 21	8½	2½– 18	6½	0 – 15	85	34–160	25	3 – 90	....	4– 7[illegible]
Poltava	9	4½– 16	8½	4½– 15	5½	0 – 20	65	30– 90	35	6 – 90	28	5– 5[illegible]
III.—Southwestern:												
Kiev	11½	4 – 23	10	5 – 16	9	4 – 18½	72	14–110	38	11 – 80	31	15– 6[illegible]
Podolia	7½	4 – 24	7	4 – 24	6	2½– 8	76	30–140	30	2 – 50	25	2– 5[illegible]
Volhynia	6	½– 14	5	1½ – 14	....	....	65	60– 70	25	10 – 50	18	3– 4[illegible]
IV.—Northern:												
Kursk	10½	4 – 22	9	3 – 20	7	0 – 20	72	20–130	50	10 –150	44	12– 7[illegible]
Tshernigov	7½	3 – 17	7½	3 – 14½	....	....	76	20–125	40	4 –150	30	4–15[illegible]
Orlov [Orel]	9½	4 – 19	7½	3 – 16	....	....	....	....	55	25 –120	35	20– 7[illegible]
Tambov	11½	2 – 26	10	2 – 26	....	....	70	39–107	60	23 –120	50	25–10[illegible]
Tula	11	5 – 18	9	2 – 17	....	....	....	60– 80	55	18 –105	48	15– 8[illegible]
Riazan	11	4½– 25	9	4 – 17	....	....	....	....	55	20 –120	45	15– 9[illegible]
Penza	8½	3 – 27	8½	3 – 22	....	....	....	40	60	27 –100	45	19– 9[illegible]
V.—Eastern and Southeastern:												
Kazan	11½	6 – 23	9	3 – 21	....	....	....	....	55	20 –120	45	16– 9[illegible]
Simbirsk	11½	6½– 20	10	6 – 20	....	....	....	....	55	12 –100	50	20–10[illegible]
Samara	12	3 – 34	11	3 – 20	....	15	....	40– 60	35	1 –133	30	0–13[illegible]
Orenburg	7½	0 – 15½	6½	1 – 12	....	....	....	....	....	½– 33	....	2– 3[illegible]
Ufa	11	7 – 20	10	6 – 17	....	....	....	....	40	15 –100	35	15– 5[illegible]
Saratov	11½	3 – 23	10	3 – 21	....	7½– 14½	....	....	55	16 –120	40	20– 8[illegible]
Astrakhan	....	6 – 10	....	6 – 10	....	....	....	....	....	....	....	....
Ural Province	....	5 – 10	....	5 – 10	....	....	....	....	....	24	....	[illegible]
B.—NON-BLACKEARTH REGION.												
I.:												
Moscow	11½	6 –20	9	4 –15	....	....	....	....	60	23 –113	45	20–1[illegible]
Tver	13½	7 –28	9½	3 –18	....	....	....	....	70	15 –300	55	16–2[illegible]
Smolensk	10	5 –25	8½	3 –20	....	....	....	....	60	20 –140	50	10–1[illegible]
Kaluga	8½	4½–15	7½	1 –10	....	....	....	....	60	21 – 80	45	30– [illegible]
Vladimir	8½	1 –20	7	1 –15	....	....	....	....	45	9 –120	40	12–1[illegible]
Yaroslav	12½	4 –23	10½	4 –23	....	....	....	....	80	35 –186	70	25–1[illegible]
II.—Western:												
Kovno	10	1½–22	8½	2 –18	....	....	....	....	40	1 –150	35	1–17[illegible]
Vilna	7	3 –18	5½	3 –15	....	....	....	....	35	4 – 80	30	4– [illegible]
Grodno	5½	1 –11	4½	1 –10	....	....	....	....	35	10 – 90	30	10– [illegible]
Vitebsk	9	3 –15	7½	3 –12	....	....	....	....	30	5 – 80	28	5– 8[illegible]
Minsk	5½	2½–12	5	2½–12	....	....	....	....	40	10 –100	30	8– 8[illegible]
Mohilev	9	3½–20	8	3 –15	....	....	....	....	50	3 –114	40	6– 8[illegible]
III.—Near the Vistula	6½	3 –17	6½	3 –17	....	....	....	....	37	5 – 72	36	6– 6[illegible]
IV.—Near the Baltic:												
Livonia	13½	8 –34	11	8 –25	....	....	....	....	60	10 – 90	45	[illegible]
Courland	12½	7 –28	11	4 –16	....	....	....	....	60	4 –120	50	[illegible]
Esthonia	12	6½–20	9	5 –20	....	....	....	....	50	0 –100	35	[illegible]
V.—Northwestern:												
Pskov	10½	5 –22	8½	5 15	....	....	....	....	45	20 –113	40	[illegible]
St. Petersburg	10	5 –20	7½	5 15	....	....	....	....	60	15 –220	45	[illegible]
Novgorod	10	3½–30	8	2 20	....	....	....	....	40	20 –100	40	[illegible]

TABLE III.—*Yield of field plants in Russia*—Continued.

Governments.	Average per desiatine, and range from minimum to maximum.											
	Oats on lands of—				Maize on lands of—		Sugar beets on lands of—		Potatoes on lands of—			
	Proprietors.		Peasants.		Proprietors.		Proprietors.		Proprietors.		Peasants.	
	Av.	Range.	Av.	Range.	Av.	Range.	Av.	Range.	Av.	Range.	Av.	Range.
B.—NON-BLACKEARTH REGION—Continued.												
VI.—Central Volgian and Trans-Volgian:												
Kostromo	9	3½-15	7½	3 -18	...	....	...	....	45	30 -114	40	16-100
Nizhni-Novgorod	6½	3½-16	5½	2 -12	...	....	...	....	50	20 -160	40	17-160
Viatka	8	2½-18	7	2½-12	...	....	...	....	35	7 -100	25	7- 80
Perm	8	2½-13	7	½-20	...	....	...	....	...	25 - 45	...	8- 20
VII.—Northern:												
Vologda	11	1 -25	10	4 -21½	...	....	...	....	50	4 -120	40	10-100
Olonets	7½	6 -17	7	3½-18	...	....	...	....	...	45 - 90	40	11-160
Archangel	...	....	11½	8 -15½	...	....	...	....	...	50 -180	...	20-120

The following quotations represent as nearly as possibl

MARKET PRICES OF FAR

Product.	January.	February.	March.	April.	May.
NEW YORK.*					
Flour:					
Superfine ....bbl.	$2 70 to $3 05	$2 60 to $3 25	$2 80 to $3 25	$2 55 to $3 25	$3 15 to $3 [illegible]
Spring wheat extras, good to choice ....bbl.	3 70 to 3 85	3 50 to 3 60	3 55 to 3 70	3 40 to 3 50	3 00 to 3 [illegible]
Winter wheat extras, white ....bbl.	4 25 to 4 70	3 75 to 4 60	3 90 to 5 00	3 60 to 4 50	3 90 to 4 [illegible]
Patents, spring wheat..do.	5 80 to 7 00	5 40 to 6 55	5 50 to 6 85	5 40 to 6 50	5 25 to 6 [illegible]
Wheat:					
No. 2 white ....bush.	1 05 to 1 07	Nominal.	Nominal.	Nominal.	Nominal.
No. 2 red winter ......do..	1 10⅞ to 1 11	1 06 to 1 08	1 07¼ to 1 09¾	1 01 to 1 03¼	1 09 to 1 1[illegible]
Corn:					
No. 2 mixed ....bush.	65 to 65½	61½ to 62¾	62 to 63	60¼ to 61¾	61½ to 6[illegible]
Ungraded mixed......do..	50 to 65	54 to 59	59 to 61	46 to 59	....
Barley:					
No. 2 Canada ....bush.	83 to 85	Nominal.	82	85 to 91	89
State...................do..	70 to 74	Nominal.	....	....	....
Oats, No. 2 mixed......do..	49 to 40¼	39½ to 40	40 to 40½	37¾ to 39½	Nominal.
Rye, State ....do..	73 to 73½	....	....	74 to 79½	74 to 7[illegible]
Potatoes ....bbl.	1 25 to 1 75	1 50 to 2 00	75 to 1 25	87½ to 1 25	70 to 1 2[illegible]
Hay:					
First quality timothy, tons	17 00 to 18 00	17 00 to 18 50	18 00	18 00 to 19 00	19 00 to 20 00
Second quality timothy, tons.........................	14 00 to 16 00	14 00 to 16 00	15 00 to 16 00	16 00 to 17 00	17 00
Beef:					
Extra mess ....bbl.	12 00 to 12 50	12 50 to 13 00	12 00 to 13 00	12 00 to 13 00	12 00
Hams..................do..	23 50 to 24 00	25 50 to 26 00	28 00 to 28 50	27 00 to 27 50	....
Pork:					
Extra prime ....do..	13 50	15 00 to 16 00	17 00 to 17 50	16 50 to 17 00	16 00 to 16 50
Prime mess ....do..	15 00 to 15 50	16 20 to 16 50	17 50 to 17 85	17 50 to 17 75	17 00
Lard, prime city ..cental	8 75	9 30	9 35	9 50	8 40 to 8 45
Butter:					
Creamery ....lb.	25 to 36	25 to 37	25 to 35	27 to 37	21 to 2[illegible]
Western dairy.........do.	18 to 23	18 to 21	16 to 20	18 to 25	21 to 2[illegible]
State dairy.............do.	27 to 30	25 to 29	26 to 30	25 to 34	20 to 25
Cheese, State factory....do.	9¼ to 12¾	10 to 14	10½ to 14½	11 to 15	12 to 15
Eggs:					
State and Pennsylvania....................doz.	32 to 32½	37	23½	24½	14 to 14½
Western, fresh.........do.	31 to 31½	36 to 37	23 to 23½	24 to 24½	14 to 14½
Sugar:					
Fair to good refining ..lb.	6 3/16 to 6 5/16	5 13/16 to 5 15/16	5⅝ to 5¾	5 7/16 to 5 9/16	5 5/16 to 5 [illegible]
Cotton:					
Ordinary to good ordinary (N. O. and Gulf) .lb.	8 7/16 to 9 11/16	8¾ to 10	8⅞ to 9 5/16	9 7/16 to 10 11/16	9¾ to 10 3/16
Low middling to good middling (N. O. and Gulf)...................lb.	10 3/16 to 10 13/16	10 7/16 to 11¼	10¾ to 11⅜	11 5/16 to 11 11/16	11 5/16 to 12[illegible]
Tobacco:					
Pennsylvania seed leaf lb.	10 to 18	6½ to 10	5 to 20	8 to 20	10 to 16
Wool:					
Combing and delaine fleeces..................lb.	32 to 45	....	45	....	....
California..............do.	21½ to 27	....	....	....	....
Ohio and Pennsylvania ....lb.	37 to 41	....	41	....	38 to 39½
BOSTON.					
Flour:					
Western, superfine, spring ....bbl.	3 00 to 3 50	3 00 to 3 25	3 00 to 3 25	2 75 to 3 25	2 75 to 3 15
Common, extras ......do..	3 75 to 4 25	3 25 to 4 00	3 25 to 4 00	3 25 to 4 00	3 25 to 4 00
Patents, winter.......do..	6 00 to 6 50	6 00 to 6 50	6 00 to 6 25	6 00 to 6 75	5 75 to 6 70
Wheat:					
No. 2 red winter....bush.	1 11½ to 1 14½	1 05½ to 1 07	1 08 to 1 10	1 05¾ to 1 07½	1 11 to 1 12½
Rye.......................do	[illegible] to 78	75 to 76	72 to 73	72 to 74	78 to 80
Barley:					
State...................do..	70 to 95	70 to 80	62 to 93	62 to 76	64 to 78
Oats:					
No. 2 white............do..	42 to 42½	44½ to 45	45 to 45½	44 to 44½	44
No. 2 mixed.........do..	39 to 41	40 to 41	43 to 44	42 to 43	41 to 43
Corn:					
No 2 mixed ....do	....	58 to 62	67 to 68	62 to 65	63 to 64

* Rail

the state of the markets at the beginning of each month:

PRODUCTS FOR 1884.

June.	July.	August.	September.	October.	November.	December.
$2 80 to $3 30	$2 65 to $3 15	$2 80 to $3 20	$2 35 to $2 90	$2 35 to $2 80	$2 00 to $3 00	$2 25 to $2 85½
3 60 to 3 70	3 45 to 3 55	3 55 to 3 65	3 20 to 3 30	3 20 to 3 25	3 30 to 3 50	2 80 to 3 10
4 00 to 4 50	4 00 to 4 50	4 50 to 5 00	4 00 to 4 30	3 25 to 3 75	3 20 to 3 40	2 85 to 3 20
5 25 to 6 50	5 00 to 6 10	5 40 to 6 00	5 25 to 6 10	5 40 to 6 15	4 75 to 5 50	4 25 to 5 00
Nominal.	Nominal.	Nominal.	Nominal.	Nominal.	Nominal.	Nominal.
1 01 to 1 03	94 to 95½	95½ to 96¾	90½ to 92	88 to 90	85 to 87	83 to 84
65 to 66	58 to 60	62½ to 64	65 to 67½	59 to 60	53½ to 54½	51 to 56
......	......	......	......	......	......	......
......	......	......	......	......	......	......
......	......	......	......	......	60	......
38½	34 to 34½	36 to 36½	33½ to ..	31½	32½	30½
......	......	Nominal.	......	......	61	......
87½ to 1 25	2 00 to 2 50	1 75 to 2 00	1 75 to 2 25	1 12½ to 1 75	1 15 to 1 37	1 12½ to 1 37
21 00	19 00 to 20 00	19 00 to 21 00	21 00 to 22 00	18 00 to 20 00	18 00	17 00 to 19 00
17 00 to 19 00	17 00 to 18 00	17 00 to 18 00	18 00	17 00 to 18 00	16 00 to 17 00	15 00 to 16 50
......	......	......	......	......	......	......
22 50	27 00 to 27 50	30 00	24 50 to 25 00	19 75 to 20 00	21 00 to 21 50	20 00
15 75 to 16 00	14 50	14 50 to 15 00	15 00 to 16 00	15 00 to 15 50	14 00 to 14 50	11 00
......	......	16 50 to 17 00	18 50 to 18 75	17 00 to 17 25	16 50 to 16 75	12 75 to 13 00
8 10	7 20	7 40	7 80	7 55	7 25	7 05 to 7 10
16 to 22	10½ to 22	16 to 23	17 to 24	26 to 31	23 to 32	28 to 31
17 to 20	10 to 19	16 to 19	16 to 19	16 to 24	16 to 24	16 to 24
20 to 21	15 to 20	15 to 20	15 to 21	22 to 26	25 to 28	25 to 28
9 to 11	9 to 9½	7½ to 10½	7½ to 10	10¾ to 12	11 to 12¾	12½ to 12¾
16½ to 17	19½ to 20	18 to 18½	18 to 19	21 to 21½	24½ to 25	28 to 28½
16 to 16½	18½ to 19	17 to 17½	17½	21 to 21½	24 to 24½	......
$4\frac{15}{16}$ to $5\frac{1}{16}$	$4\frac{13}{16}$ to $4\frac{15}{16}$	4⅞ to 5	$4\frac{13}{16}$ to $4\frac{15}{16}$	4⅞ to 5	5 to 5⅛	$4\frac{13}{16}$ to $4\frac{15}{16}$
$9\frac{9}{16}$ to $10\frac{13}{16}$	9 to 10¼	$9\frac{1}{16}$ to $10\frac{15}{16}$	8⅞ to 10⅛	8⅛ to 9⅜	7⅛ to 9⅛	8⅛ to 9⅝
$11\frac{7}{16}$ to $12\frac{1}{16}$	10⅞ to 11⅛	$10\frac{13}{16}$ to $11\frac{9}{16}$	10⅞ to 11⅜	10 to $10\frac{9}{16}$	9¾ to $10\frac{5}{16}$	10⅜ to $10\frac{15}{16}$
......	......	......	6 to 15	5½ to 15	6 to 10½	6 to 11
38 to 40	......	34 to 36	37½	31 to 36	26 to 28	24 to 27
......	......	13 to 23	15 to 18	13 to 23	9 to 24	10 to 23
......	......	......	35	35 to 36	33 to 36	32 to 36
3 00 to 3 50	2 75 to 3 25	2 75 to 3 00	2 50 to 3 00	2 50 to 2 75	2 65 to 3 00	2 50 to 2 75
3 50 to 4 25	3 25 to 4 00	3 25 to 3 75	3 25 to 3 75	3 00 to 3 50	3 00 to 3 50	2 75 to 3 25
6 00 to 6 75	5 75 to 6 50	5 50 to 6 00	5 00 to 6 00	5 00 to 5 60	4 75 to 5 25	4 50 to 5 00
1 02 to 1 04	98½ to 1 00½	98 to 99	86 to 87	88 to 89½	85 to 80	83 to 84
75 to 78	75 to 78	80 to 85	80	70 to 72	70 to 75	70 to 72
65 to 80	68 to 83	......	......	......	......	......
41	39¾ to 40	46 to 47	41 to 42	36 to 37	34½ to 35	35 to 35½
39 to 40	37 to 38	42 to 43	35 to 36	32 to 34	32 to 33	32 to 33
65 to 65½	62 to 63	70 to 71	68 to 70	68 to 69	62 to 63	57 to 58

MARKET PRICES OF F

Product.	January.	February.	March.	April.	Ma
BOSTON—Continued.					
Potatoes..............bush.	$0 40 to $0 50	$0 40 to $0 48	$0 40 to $0 46	$0 38 to $0 47	$0 35 t
Hay:					
Choice..............ton.	16 00	16 00	15 00 to 16 00	15 00 to 16 00	16 00 t
Good..............do..	14 00 to 15 00	14 00 to 15 00	13 00 to 14 00	13 00 to 14 00	15 00 t
Pork:					
Extra prime.........bbl.	13 50 to 14 00	13 50 to 14 00	17 00	17 00 to 17 50	16 50 t
New mess...........do..	16 00 to 16 50	16 50 to 17 00	19 00 to 19 50	19 00 to 19 50	17 50 t
Beef:					
Western extra mess..do..	13 00 to 14 00	13 00 to 14 00	13 to to 14 00	13 00 to 13 50	13 00 t
Western extra plate .do..	14 50 to 15 00	14 50 to 15 00	15 50 to 16 00	13 50 to 16 00	14 00 t
Lard..................lb.	9¼ to 9½	9½ to 10	10¼ to 11½	9⅞ to 11	9 to
Butter:					
Northern creamery.. do..	24 to 35	25 to 35	23 to 32	18 to 30	25 to
Western creamery...do..	23 to 36	24 to 36	22 to 35	25 to 35	25 to
Cheese:					
Northern factory, extra..................lb.	12¾ to 13¼	13¾ to 14	15	15 to 15½	14½ to
Western factory, extra.do.	12¼ to 12¾	12½ to 13	12½ to 13½	12½ to 14	12¾ to
Eggs..................doz.	28 to 33	25 to 33	22½ to 23	23½ to 24½	15 to
Sugar:					
Fair to good refining ..lb.	6 3/16 to 6 5/16	5⅞ to 6	5¾ to 5⅞	5½ to 5⅝	5 3/16 to
Cotton:					
Ordinary to good ordinary...............lb.	8¼ to 9¾	8½ to 10	8⅛ to 10⅛	9 to 10½	9½ to
Middling to middling fair..................lb.	10½ to 11⅛	10⅜ to 11⅞	10⅞ to 12	11½ to 12⅜	11¾ to
Tobacco:					
Choice leaf............do.	11 to 13	11 to 13	11 to 13	....	11 to
Good Western leaf. ..do.	10 to 12	10 to 12	10 to 12	....	10 to
Lugs..................do.	5½ to 9	5½ to 9	5½ to 9	....	5½ to
Wool:					
Pick-lock and XXX, O. and Penn............lb.	42 to 43	42 to 43	40 to 42	35½ to 40	40 to
Pulled.................do.	15 to 38	15 to 38	15 to 38	....	15 to
Combing and delaine .do.	32 to 42	20 to 45	22 to 45	38½ to 40	27 to
Grass seeds:					
Clover, New York.....do.	11 to 11½	11 to 11½	11 to 11½	10½ to 11	10½ to
Timothy............bush.	1 00 to 1 70	1 60 to 1 70	1 60 to 1 70	1 60 to 1 70	1 55 to
Red top.............bag*.	2 50 to 2 75	2 30 to 2 50	2 30 to 2 50	2 30 to 2 50	2 00 to
Apples.................bbl.	....	....	....	....	2 00 to
PHILADELPHIA.					
Flour:					
Superfine Western and Pennsylvania......bbl.	3 00 to 3 50	2 75 to 3 25	2 75 to 3 00	2 50 to 3 00	2 50 to
Minnesota "straight," bakers'.............bbl.	5 65 to 6 00	5 40 to 6 00	5 37½ to 6 00	5 37½ to 6 00	5 65 to
Winter patents........do.	6 00 to 6 75	6 00 to 6 65	6 00 to 6 70	5 75 to 6 60	6 00 to
Spring patents........do.	6 37½ to 7 00	6 00 to 6 75	6 00 to 6 75	6 00 to 6 75	6 37½ to
Wheat, No. 2 red.....bush.	1 06¾ to 1 11	1 07½	1 08¾	1 01⅛ to 1 02½	1 12
Corn, sail mixed........do.	59 to 61	58½ to 59	60 to 60½	56 to 57	57
Rye....................do.	65	65	65 to 68	64 to 66	70 to
Oats, No. 2............do.	35 to 41	40½ to 41	44	42½ to 42¾	40½ to
Potatoes...............do.	35 to 42	33 to 40	31 to 39	30 to 40	25 to
Hay, timothy..........ton.	13 00 to 15 00	13 00 to 16 00	10 00 to 15 00	11 00 to 16 00	15 00 t
Beef:					
Family...............bbl.	13 50 to 14 00	14 00	14 00	14 00 to 14 50	14 00
India mess, in tierces, tierce..................	24 00	24 50 to 25 00	24 50	24 00 to 24 50	23 00
Hams.................bbl.	24 00 to 24 50	26 00 to 26 50	28 50 to 29 00	27 75 to 28 00	26 50 to
Pork:					
Mess..................do.	16 00	17 00 to 17 50	19 50	19 00 to 19 50	18 50 to
Prime mess............do.	14 50 to 15 00	16 00	18 00	18 00	17 50
Lard...............cental.	8 50 to 9 75	10 00	10 00 to 10 50	9 50 to 10 25	8 70 to
Butter:					
Creamery..............lb.	25 to 35	28 to 36	28 to 32	25 to 37	27 to
Western dairy........do.	10 to 22	14 to 20	17 to 22	18 to 25	19 to
Cheese:					
New York factory ... do.	10 to 14	10 to 14½	13 to 14½	13½ to 15	12½ to
Pennsylvania creamery, pound..................	8 to 9	8⅝ to 9	8 to 9½	8¾ to 9	7 to
Eggs..................doz..	29 to 30	31 to 35	21 to 22½	22 to 22½	12 to
Sugar, fair to good refining, pound..................	5 7/16 to 5½	5 13/16 to 5 15/16	5⅝ to 6	5½ to 5⅝	5½ to
Apples.................bbl.	....	....	....	....	....

*A "bag" is 5 bushels, or 50 pounds.

PRODUCTS FOR 1884—Continued.

June.	July.	August.	September.	October.	November.	December.
$0.35 to $0.40	$0.30 to $0.55	$0.35 to $0.50	$0.40 to $0.45	$0.45 to $0.55	$0.50 to $0.55	$0.45 to $0.55
17.00	16.50	18.00 to 19.00	19.00 to 20.00	17.00 to 19.00	19.00	17.00 to 19.00
15.00 to 16.00	15.00 to 15.50	16.00 to 17.00	17.00 to 18.00	17.00 to 18.00	17.00 to 18.00	17.00 to 18.00
16.50 to 16.75	15.50 to 16.00	15.00 to 15.50	15.50 to 16.00	15.00 to 15.50	15.00 to 15.50	12.50 to 13.00
17.00 to 17.50	16.75 to 17.25	16.00 to 16.50	18.50 to 19.00	17.00 to 17.50	17.00	13.50 to 14.00
12.00 to 12.50	11.00 to 12.50	12.00 to 12.50	12.50 to 13.00	12.00 to 12.50	12.00 to 12.50	12.00 to 12.50
13.50 to 14.00	13.00 to 14.00	13.50 to 14.00	13.00 to 13.50	14.00 to 14.50	12.50 to 13.00	13.00 to 13.50
8⅝ to 10½	8¼ to 10	8 to 9½	8½ to 9¼	8¼ to 9	8 to 9	7½ to 8¼
18 to 21	19 to 22	19 to 23	19 to 23	21 to 30	21 to 31	20 to 30
18 to 21	18 to 21	17 to 22	17 to 22	20 to 28	20 to 30	20 to 30
11 to 11½	9	9½ to 10	10¾ to 11	11 to 11½	12 to 13	12 to 12¾
10 to 11	8½ to 8½	9 to 9½	9 to 9½	10½ to 11	9 to 12	14¼ to 11¾
14 to 16½	15½ to 17½	19½ to 21	17 to 20	16 to 23	19 to 29	20 to 29
5¼ to 5 5/16	4 13/16 to 5	5 to 5½	4⅞ to 5½	4⅞ to 5	....	....
9⅝ to 10⅞	8⅝ to 8⅞	9 to 10½	8½ to 10½	8 to 9½	7⅝ to 8⅞	8½ to 9¾
11⅛ to 12¾	11⅛ to 12¼	11⅛ to 12¼	11¼ to 12	10 to 11½	9⅞ to 10⅝	10¾ to 11⅛
11 to 13	....	....	....	....	....	....
10 to 12	....	....	....	....	....	....
5½ to 9	....	....	....	....	....	....
35 to 38	35 to 37	31 to 35	....	36 to 36½	32 to 36	35 to 36
20 to 38	30 to 35	....	....	....	25 to 35	22 to 35
23 to 27	35 to 37	32½ to 37	33 to 37	33 to 37	35 to 37	35 to 37
10½ to 11	10½ to 11	10½ to 11	10½ to 11	10½ to 11	10½ to 11	10½ to 11
1.55 to 1.70	1.55 to 1.70	1.55 to 1.70	1.60 to 1.80	1.60 to 1.80	1.60 to 1.80	1.60 to 1.80
2.00 to 2.20	2.00 to 2.20	2.00 to 2.20	2.00 to 2.20	2.00 to 2.20	2.00 to 2.20	2.00 to 2.20
2.50 to 5.50	....	1.50 to 3.00	.75 to 1.75	1.50 to 3.50	.75 to 3.25	.75 to 3.00
2.50 to 3.00	2.50 to 3.00	2.50 to 2.75	2.50 to 2.75	2.25 to 2.75	2.25 to 2.50	2.00 to 2.50
4.75 to 5.75	5.00 to 5.50	5.25 to 5.50	5.50	5.25 to 5.50	5.00 to 5.25	4.50 to 4.75
5.75 to 6.50	6.00 to 6.25	5.75 to 6.50	5.75	5.50 to 5.75	5.00 to 5.50	4.75 to 5.25
5.75 to 6.50	6.00 to 6.25	6.00 to 6.15	6.00 to 6.10	5.75 to 6.25	5.00 to 6.00	5.00 to 5.25
1.02¾ to 1.03¾	94*	90	88	85	81	79
62½	55 to 57	57 to 60	65	65	62	45½ to 46
70	70	70	60 to 62	64 to 65	63	....
40¾ to 41¾	35 to 37	34 to 36	37	34	34	35¼ to 35½
22 to 35	40 to 65	45 to 65	50 to 55	50 to 55	50	....
17.00 to 18.00	13.00 to 16.50	14.00 to 15.00	18.00 to 19.00	16.00 to 17.00	16.50	17.00 to 19.00
14.00	13.50	13.50 to 13.75	13.50 to 14.00	13.50 to 14.00	13.00 to 14.00	13.50 to 14.00
23.00	19.50 to 20.00	22.00	24.00	22.50	22.00	21.50
25.00	28.00 to 29.00	27.00 to 29.00	25.00 to 26.00	20.00 to 20.50	21.00	21.00 to 21.50
18.00 to 18.50	16.50 to 17.00	16.75 to 17.00	18.00 to 19.00	18.00 to 18.50	17.00	16.00
17.50	16.00	....	17.00	17.00	17.00	15.00
9.00 to 9.25	7.50 to 8.75	7.75 to 8.75	8.75 to 9.00	7.75 to 8.75	7.00 to 7.25	7.00 to 8.25
19 to 20	18 to 21	18 to 20	20 to 22	27 to 31	26 to 30	20 to 30
16 to 17	11 to 15	12 to 14	18 to 21	19 to 24	19 to 22	20 to 25
13½ to 15½	9 to 10	10 to 11	10 to 11	10¼ to 12	11 to 13	11½ to 13
11½ to 12	....	7 to 9	6 to 9	7 to 9	....	....
12 to 13	18 to 19	18 to 19	20 to 21	20 to 22	22	26 to 30
5 to 5⅛	....	....	....	....	....	....
3.00 to 4.50	2.50 to 4.00	....	.50 to 1.50	1.00 to 2.50	1.00 to 2.25	1.50 to 2.50

* Lowest price in thirty years.

MARKET PRICES OF FAR[M]

Products.	January.	February.	March.	April.	May.
BALTIMORE.					
Flour:					
Ohio and Indiana superfine ....bbl.	$3 00 to $3 50	$2 75 to $3 25	$2 75 to $3 50	$2 75 to $3 25	$3 25 to $[illegible]
Ohio and Indiana family, barrel	5 00 to 5 50	4 90 to 5 50	5 00 to 5 63	4 75 to 5 50	5 25 to 5 5[illegible]
Patents, Baltimore winter, barrel	7 00	7 00	7 00	7 00	7 00
Wheat, No. 2 red .....bush.	1 06 to 1 07	1 06½	1 08½ to 1 08¾	1 02 to 1 02¼	1 03¾ to 1 04¼
Corn, regular mixed, Western ....bush.	58	58¼ to 58½	60 to 61½	50 to 52	60
Rye, Pennsylvania and Maryland ....bush.	73 to 74	67 to 69½	68 to 70	67 to 68½	66 to [illegible]
Oats, Pennsylvania and Maryland ....bush	38 to 42	40 to 43	43 to 45	40 to 43	39 to 40
Potatoes ....do.	30 to 55	45 to 50	30 to 40	30 to 50	35 to 45
Hay, timothy ....ton.	13 00 to 17 00	14 00 to 18 00	14 00 to 17 00	14 00 to 17 00	15 00 to 18 00
Pork:					
Mess ....bbl.	15 50	16 50	18 00 to 19 00	18 00 to 19 00	17 25 to 18 25
Bacon, shoulders ......lb	7½	8	9	8¾	8½
Sugar-cured hams ....do.	14½ to 15	14 to 14½	14¾ to 15¼	14¾ to 15¼	14½ to 15
Sugar-cured shoulders.do.	9	8¾ to 9	9½	9¼	9¼
Lard, refined ....cental.	10 00	10 00	10 00	10 00	9 75
Butter:					
Creamery ....lb.	30 to 35	30 to 35	22 to 35	22 to 39	26 to 30
New York State, good to choice ....lb.	23 to 32	23 to 32	23 to 30	26 to 28	23 to 3[illegible]
Western factory ......do.	15 to 18	15 to 18	15 to 18	20 to 22	18 to 20
Cheese:					
New York choice ......do.	13½	13¾ to 14½	14 to 15	15½	13 to 14
Western choice. ......do.	12 to 12½	13 to 13½	13½ to 14	....	....
Eggs, fresh ....doz.	27 to 28	40 to 42	18 to 19	20 to 21	12 to 13
Sugar, fair refining ......lb.	6⅛ to 7	6½ to 6¾	6⅛ to 6⅜	5⅜	5⅜ to 6
Cotton:					
Ordinary to good ordinary ....lb.	8½ to 9½	9 to 9⅝	9 to 9¾	9¼ to 10¼	9⅛ to 10
Low middling to middling ....lb.	9⅞ to 10⅜	10½ to 10⅝	10¼ to 10⅝	10¾ to 11¼	11¼ to 11¾
Tobacco:					
Good to middling, Maryland ....cental.	4 00 to 8 00	4 00 to 8 00	4 00 to 8 00	4 00 to 8 00	4 00 to 8 00
Common Kentucky leaf, cental	8 00 to 9 00	8 00 to 9 00	8 00 to 9 00	8 00 to 9 00	8 00 to 9 00
Good Kentucky lugs, cental	7 00 to 8 00	7 00 to 8 00	7 00 to 8 00	7 00 to 8 00	7 00 to 8 00
Common and good Virginia lugs ....cental.	6 50 to 8 00	6 50 to 8 00	6 50 to 8 00	6 50 to 8 00	6 50 to 8 00
Rice, Carolina, prime to choice ....lb.	5⅛ to 6¼	6¼ to 6¾	6⅛ to 6⅜	6⅛ to 6⅝	6⅛ to [illegible]
Wool:					
Tub washed ....do.	33 to 36	33 to 36	....	....	34 to 36
Fleece washed ....do.	30 to 32	30 to 32	....	....	32 to 34
Good unwashed ......do.	24 to 26	24 to 26	....	....	24 to 26
Merino ....do.	22 to 23	22 to 23	....	....	24 to 26
Apples ....bbl.	....	....	....	....	....
CHICAGO.					
Flour:					
Winter ....bbl.	4 10 to 5 00	4 10 to 5 00	4 20 to 4 50	....	....
Spring ....do.	....	4 50 to 4 70	4 75 to 5 05	4 25 to 5 75	4 12½ to 4 [illegible]
Wheat:					
No. 2 spring ....bush.	93⅛ to 93¾	93 to 93⅞	92½ to 92¾	83 to 86½	92¼ to 93
No. 2 red winter ......do.	98	99	1 03	1 00½ to 1 01	1 05
Barley ....do.	61½ to 62	59 to 62	50 to 60	58 to 66	68 to 74
Corn, No. 2 ....do.	54¼ to 56½	54 to 56	53¼ to 53½	51 to 54⅛	54½ to 56
Oats, No. 2 ....do.	32½ to 32¾	32 to 34	33¼ to 35	29¼ to 35¾	32½
Rye, No. 2 ....do.	58⅛	59	58½ to 60	61 to 61½	62
Potatoes ....do.	35 to 38	35 to 36	30 to 34	32 to 42	30 to 40
Hay:					
Timothy, 1st quality.ton.	9 to 9 50	10 00	10 12½ to 10 50	11 00 to 12 00	13 00 to 14 00
Timothy, 2d quality..do.	....	9 00	8 50	10 00 to 12 00	....
Beef:					
Mess ....bbl.	....	....	11 75 to 12 00	....	....
Hams ....do.	....	....	26 50 to 27 00	....	....
Pork:					
Mess ....do.	....	....	17 85	18 25	
Bacon, short clears, cental.	....	....	10 25 to 10 50	....	....
Ham, sweet pickled..do.	....	....	12 00 to 12 50	....	....

PRODUCTS FOR 1884—Continued.

June.	July.	August.	September.	October.	November.	December.
$2 75 to $3 50	$2 75 to $3 37	$2 50 to $3 00	$2 37 to $2 75	$2 25 to $2 65	$2 25 to $2 75	$2 25 to $2 65
4 50 to 5 50	4 50 to 5 50	4 25 to 5 25	4 00 to 5 00	3 75 to 4 75	3 75 to 4 75	3 50 to 4 50
6 75	6 75	6 25	6 25	6 00	6 00	5 25
1 04	98½	91½ to 94½	88¼ to 88½	84 to 84½	81¼ to 81½	79 to 79½
60 to 60½	56 to 56½	62½	...	61	...	44 to 46
70 to 70½	60 to 70	62 to 65	56 to 58	65	...	...
38	37 to 40	42 to 45	30 to 35	35 to 40	31 to 35	35
45 to 55	50 to 75	50 to 65	40 to 60	40 to 50	45 to 55	35 to 50
15 00 to 18 00	13 00 to 17 00	20 00 to 21 00	17 00 to 18 00	16 00 to 17 00	13 00 to 17 00	13 00 to 18 00
18 00	17 50	17 00	19 25	17 75	17 00	13 50
8¼	8	7½	8¾	8½	8½	8
14½	14¾	14¾ to 16	15½ to 16½	15½ to 16½	15½ to 16½	12½ to 14
9½	9¾	9¾	10½	10	9¾	8½
9 75	9 25	9 25	9 25	9 25	8 75	8 75
20 to 28	15 to 23	20 to 22	20 to 23	26 to 32	20 to 32	26 to 31
18 to 22	15 to 18	15 to 18	15 to 21	15 to 25	18 to 28	20 to 28
16 to 20	8 to 10	12 to 13	9 to 13	9 to 15	15 to 17	15 to 17
12 to 13	10½ to 11	10 to 10½	11 to 11¼	12 to 12½	13 to 13½	13½
...	9½ to 10	8½ to 9	9 to 9½	10½ to 11	11½ to 12	12½ to 13
12 to 15	16 to 17	13 to 14	17	22 to 23	24 to 25	27 to 28
5	4¾ to 4½	4⅞ to 5	4⅞ to 5	...	...	...
10⅝	10	8¾ to 10	8½ to 9½	...	8¼ to 8½	9¼ to 9½
14¼ to 11½	11 to 11⅝	10½ to 11	10⅜ to 10⅞	9¾ to 10	9½ to 9⅝	10 to 10⅜
4 00 to 8 00	6 00 to 11 00	4 00 to 8 00	4 00 to 8 00	4 00 to 8 00	4 00 to 8 00	4 00 to 8 00
8 00 to 9 00	8 00 to 9 00	8 00 to 9 00	8 00 to 9 00	8 00 to 9 00	8 00 to 9 00	8 00 to 9 00
7 00 to 8 00	7 00 to 8 00	7 00 to 8 00	7 00 to 8 00	7 00 to 8 00	7 00 to 8 00	7 00 to 8 00
6 50 to 8 00	6 50 to 8 00	6 50 to 8 00	6 50 to 8 00	6 50 to 8 00	6 50 to 8 00	6 50 to 8 00
6¼ to 6½	6¼ to 6¾	6¼ to 6½	6¼ to 6½	6¼ to 6½	5⅞ to 6¼	5⅞ to 6¼
...	30 to 32	30 to 32	...	30 to 31	30 to 31	30 to 31
...	...	...	...	...	...	...
...	20 to 23	20 to 22	...	20 to 23	20 to 22	20 to 22
...	...	...	...	...	...	18 to 19
3 00 to 4 00	3 00 to 3 20	1 50 to 2 00	75 to 2 00	1 50 to 2 00	1 25 to 2 50	1 50 to 2 75
4 25	4 00 to 5 00	...	4 10	3 55 to 3 90	3 09	2 10 to 2 35
...	4 40	3 90	5 10	4 00 to 4 10	3 49	2 85 to 3 00
89¼ to 89½	85½	85 to 86	79¼ to 79¾	77⅞ to 78½	74⅛ to 74½	72¾ to 73½
99 to 1 01	90½	88* to 89	82½	80½ to 81	75⅝ to 76	73⅜ to 74
48 to 56½	50	41½ to 46½	47½ to 64	63 to 64	45 to 62½	46 to 62
55 to 55½	55¾ to 56⅜	55½ to 55¾	51¾ to 52½	81 to 83	41¾ to 45	35 to 35½
32 to 32½	31¾ to 32	30½ to 34½	25½ to 25⅝	25¼ to 27	26½ to 25⅝	25 to 25½
62	62½	61	54½	54½	49½	51
25 to 40	25 to 38	60	50	55	30 to 40	30 to 38
12 00 to 13 00	11 00 to 12 00	12 00 to 13 00	12 00 to 13 50	10 00 to 11 00	10 00 to 11 00	10 00 to 11 00
...	9 00 to 10 00	10 00 to 11 00	10 25 to 11 00	8 00 to 9 00	8 00 to 9 00	9 00 to 9 50
9 75 to 10 00	9 75 to 10 00	9 75 to 10 00	9 00 to 10 00	9 00 to 10 00	...	...
24 50	26 00	28 50 to 29 00	28 00 to 28 75	28 50	...	...
...	...	...	16 75	10 50	13 25 to 13 50	11 00
...	...	...	...	...	...	...
...	...	...	...	...	...	...

* New.

MARKET PRICES OF F

Product.	January.	February.	March.	April.	M
CHICAGO—Continued.					
Lard ....do..	....	....	$9 40 to $9 42	....	$8 35
Butter:					
Creamery ....lb.	$0 28 to $0 36	$0 27 to $0 33	22 to 32	$0 25 to $0 33	18
Good to choice dairy..do.	18 to 28	17 to 28	16 to 26	16 to 28	14
Cheese:					
Full cream............do.	12½ to 13	13 to 14	14 to 15	14 to 15½	14
Lower grades.........do	7½ to 9½	7 to 9	8 to 10	9 to 10	2
Eggs .... doz.	26 to 28	25 to 27	22 to 23	16 to 17½	14
Sugar, yellow ....lb.	6 to 7	6 to 7	5½ to 6	5⅝ to 6	5
Apples...................bbl	....	....	....	....	......
CINCINNATI.					
Flour:					
Superfine ....bbl.	2 90 to 3 25	2 85 to 3 10	2 85 to 3 10	2 75 to 3 00	3 10
Extra.................do..	3 50 to 3 75	3 40 to 3 65	3 50 to 3 75	3 25 to 3 60	3 70
Family.................do..	4 50 to 4 75	4 50 to 4 75	4 70 to 4 90	4 50 to 4 75	4 70
Fancy ....do..	5 00 to 5 40	5 00 to 5 40	5 15 to 5 40	5 00 to 5 25	5 25
Wheat:					
No. 3 red winter ....bush.	93 to 95	95 to 97	95 to 98	95 to 98	1 00
No. 2 red winter......do..	1 02 to 1 03	1 03 to 1 04	1 06 to 1 07	1 03 to 1 05	1 05
Corn:					
No. 2 mixed.... ....do..	50	50	52	55	[illegible]
Oats, No. 2 mixed ..do..	33½ to 37	36	37 to 39	36¼ to 36½	
Rye, No 2...............do..	62 to 63	62	65	66 to 67	—
Barley ....do..	53 to 68	58 to 65	56 to 65	68 to 73	80
Hay:					
No. 1 timothy.........ton.	10 00 to 11 00	10 50 to 11 00	11 00 to 11 50	13 00 to 13 50	14 00
Lower grades ....do..	7 00 to 9 00	9 50 to 10 00	8 00 to 10 50	9 00 to 12 50	10 00
Pork:					
Mess ......bbl.	14 50 to 14 75	16 00 to 16 25	18 00	17 50	17 25
Hams, sugar-cured ....lb.	12½ to 13½	12 to 13½	13¼ to 14½	12¾ to 13¾	12
Shoulders, sugar-cured do.	7½ to 7¾	8 to 8¼	8⅛ to 8¾	8½ to 8¾	8
Bacon, sugar-cured ...do.	9 to 10	10 to 11	10½ to 11¾	10¾ to 11½	10
Lard ....cental.	8 55 to 8 70	8 87½ to 9 05	9 35 to 9 50	9 00 to 9 25	8 25
Butter:					
Creamery ....lb.	30 to 42	35 to 41	20 to 37	30 to 36	23
Lower grades ....do.	10 to 26	10 to 22	10 to 23	15 to 25	10
Cheese:					
Choice Ohio factory...do.	10½ to 11½	11½ to 12½	11½ to 12½	10 to 11	11
Lower grades .. ...do.	9 to 10	5 to 10	8 to 11	8 to 10	8
Eggs.................doz.	22½ to 23½	36½ to 37	17 to 18	15½ to 16	12
Potatoes................bush.	35 to 40	35 to 55	35 to 50	20 to 40	20
Peanuts:					
Tennessee..............lb.	4½ to 6½	5½ to 6	6 to 7⅜	6¾ to 7¾	6
Cotton:					
Ordinary to good ordinary ....lb.	8 to 9⅓	8¼ to 9¼	8¼ to 9¼	9¼ to 11½	9¼
Low middling to good middling ....lb.	9⅞ to 10¼	9⅞ to 10⅝	10 to 10⅞	10⅛ to 11¼	11¼
Middling fair to fair ..do.	10⅞ to 11½	11⅛ to 11¾	11⅛ to 11¾	11⅛ to 12½	12¼
Apples...................bbl.	....	....	....	....	......
SAINT LOUIS.					
Flour:					
Superfine ....bbl.	2 60 to 2 75	2 60 to 2 75	2 60 to 2 75	2 60 to 2 75	2 60
Family ....do..	3 90 to 4 05	3 90 to 4 05	4 10 to 4 20	4 10 to 4 20	4 15
Patents ....do..	5 60 to 6 50	5 60 to 6 40	5 85 to 6 50	5 80 to 6 25	5 80
Wheat, No. 2 red......bush.	1 01 to 1 02	1 03¾ to 1 04½	1 08½ to 1 10½	1 08 to 1 08½	1 14
Corn, No. 2 mixed......do..	45 to 45½	46½ to 47½	48⅝ to 49	48 to 48½	49½
Rye, No. 2...............do..	54 to 54½	54¼	58	50½ to 61	50½
Barley, Wisconsin......do..	45	75	58	....	......
Oats, No. 2 ....do..	30 to 30½	32½ to 33½	35½	32 to 34½	32½
Potatoes ....do..	30 to 38	30 to 40	30 to 45	21½ to 35	25
Hay:					
Timothy...............ton.	9 00 to 12 50	9 00 to 12 00	12 00 to 14 00	13 25 to 14	14 50
Prairie..................do..	9 50 to 10 50	7 50 to 10 00	8 00 to 8 25	10 50	......
Pork:					
Mess.....................bbl.	....	16 00 to 16 75	17 87½	....	16 62½
Bacon, breakfast, sugar-cured ....lb.	9¾ to 10	10 to 10½	11½ to 12	11½ to 12	11
Hams, sugar-cured ...do.	12 to 12½	12 to 13½	13½	13½ to 16½	13
Lard, refined, tierce ..do.	8⅞ to 9	9 to 9⅛	9¼ to 9½	9¼ to 9⅝	9
Beef:					
Family extra ....bbl.	12 00 to 16 00	11 00 to 13 50	11 00 to 13 50	12 00 to 15 00	12 00
Butter:					
Creamery ....lb.	30 to 35	30 to 37	25 to 34	30 to 35	24
Dairy....................do	25 to 26	12½ to 28	25 to 28	20 to 30	15

PRODUCTS FOR 1884—Continued.

June.	July.	August.	September.	October.	November.	December.
$8 02½	....	$7 42½	$7 50	$7 12½ to $7 20	$6 90 to $7 02½	$6 70 to $6 80
16 to $0 20	$0 15 to $0 19	15 to $0 20	18 to $0 25	24 to 33	24 to 29	24 to 29
12 to 17	12 to 16	12 to 16	14 to 20	16 to 23	16 to 23	16 to 23
11 to 12	8¼ to 9½	9 to 10¼	10 to 12	10 to 13	12 to 13	11½ to 12½
2 to 5	2 to 5	5 to 9	6 to 9	8 to 10	5 to 9	5 to 8½
13½	15½ to 16	13½ to 15	13½ to 14	17½ to 18	20 to 21½	24 to 25
5¼ to 6	5⅛ to 5¾	5 to 5⅜	5⅛ to 5¼	5 to 5½	4¾ to 5¼	4¾ to 5¼
5 00 to 7 00	5 00 to 7 00	2 00 to 3 00	2 00 to 3 00	1 50 to 3 00	75 to 2 00	1 25 to 2 00
3 00 to 3 25	2 90 to 3 15	2 75 to 2 90	2 40 to 2 60	2 35 to 2 50	2 10 to 2 40	1 90 to 2 30
3 40 to 3 75	3 35 to 3 60	3 15 to 3 40	2 80 to 3 00	2 60 to 2 80	2 50 to 2 75	2 40 to 2 60
4 45 to 4 75	4 10 to 4 55	3 75 to 4 25	3 50 to 3 85	3 50 to 3 85	3 20 to 3 35	2 90 to 3 25
5 00 to 5 35	4 90 to 5 25	4 65 to 5 00	4 00 to 4 40	4 00 to 4 25	3 75 to 4 00	3 60 to 3 90
93 to 95	78	85½	74 to 75	75 to 77	70 to 75	66
1 02 to 1 03	91	87 to 88	80 to 81	80 to 81	78 to 78½	75 to 76
58 to 58½	54 to 54½	54½ to 55	53½ to 54	55	44 to 46	36 to 36½
34 to 34½	31½ to 32	34 to 34½	29 to 30½	27 to 27½	27½	28½
66	64 to 65	65	55½ to 56	55	54 to 55	53
80	....	68 to 70	56 to 71	51 to 72	50 to 71	50 to 75
14 00 to 14 50	11 50 to 12 00	12 00 to 12 50	11 00 to 11 50	10 50 to 11 00	10 50 to 11 00	11 00 to 11 50
10 00 to 13 50	9 00 to 11 00	9 00 to 11 00	9 50 to 10 50	8 50 to 10 50	9 50 to 10 00	10 00 to 10 50
19 00	15 75 to 16 00	15 25 to 16 75	18 00 to 18 25	17 00	14 75 to 15 00	12 00 to 12 75
12 to 13	12½ to 13¼	13½ to 14¼	14¼ to 14½	13¾ to 14¼	12¾ to 13¼	10¾ to 12
8 to 8¼	8 to 8½	8½ to 8¾	8½ to 8¾	8 to 8¼	8 to 8¼	6¾ to 7
10 to 10½	9¾ to 10¼	10¾ to 11	11¼ to 11¾	11¼ to 12	11¾ to 12	9¼ to 9¾
8 25	6 90 to 7 10	7 10	7 30 to 7 55	7 30 to 7 75	6 65 to 7 00	6 65 to 7 00
17 to 22	20 to 21	17 to 23	17 to 26	25 to 34	25 to 33	20 to 30
9 to 15	11 to 19	8 to 17	11 to 18	14 to 25	28 to 30	12 to 20
8 to 9	7 to 7½	7 to 7½	8 to 9	10 to 11	11½ to 12½	11½ to 12½
....	2 to 6½	3 to 5	4 to 6	4 to 7	5 to 9	10 to 11
11½	13½ to 14	11 to 12	14	15½ to 16	19 to 19½	22½ to 23
20 to 55	22 to 40	60 to 65	40 to 65	30 to 43	30 to 41	40 to 45
6⅞ to 7¼	5¾ to 6¼	4½ to 5¼	4 to 6½	5 to 6½	5 to 6½	4 to 5¾
9½ to 10½	9 to 10	8⅞ to 9⅞	8¾ to 9¾	7⅞ to 8⅞	7¾ to 8¾	8¼ to 9⅝
11¼ to 12	10⅝ to 11½	10⅝ to 11⅝	10½ to 11¼	9⅝ to 10⅝	9¼ to 9¾	9⅝ to 10⅝
12¼ to 12⅞	11¾ to 12⅞	11⅞ to 12¼	11¼ to 12¼	10⅝ to 11¼	10¼ to 10¾	10⅝ to 11⅝
4 50 to 6 00	2 50 to 3 50	1 00 to 2 00	1 00 to 3 00	1 25 to 2 50	1 50 to 2 00	1 50 to 1 75
....	....	2 00 to 2 25	2 00 to 2 25	....	....	....
4 05 to 4 10	3 40 to 3 65	3 00 to 3 25	2 75 to 3 50	2 65 to 2 75	2 40 to 2 50	2 55 to 2 70
5 80 to 6 30	5 70 to 6 25	5 25 to 5 60	4 65 to 5 10	4 40 to 5 00	4 35 to 4 90	4 35 to 4 80
1 06½ to 1 07	1 03 to 1 05	84½ to 85	81¼	80 to 80⅜	76¾ to 76⅞	75½ to 75⅞
52 to 52½	52½ to 52⅞	47 to 47½	48½ to 48⅞	61* to 66	36¾ to 38	35¼ to 35½
59 to 60	56 to 60	64	50½	51 to 52	49½ to 50½	48
....	....	....	....	47 to 49	....	55 to 57
32½ to 33½	30 to 31½	30 to 30½	25½ to 27	25⅜ to 25⅞	26 to 26½	25½ to 26⅞
25 to 35	30 to 40	35 to 40	35 to 39	40 to 47	30 to 39	30 to 52½
12 75 to 13 75	10 00 to 13 50	15 00	10 00 to 12 00	10 00 to 12 00	9 50 to 13 50	12 00 to 13 50
....	....	6 00	8 00 to 9 00	8 75 to 9 50	8 00 to 9 25	9 50 to 10 50
16 75 to 18 00	15 00	16 50 to 17 00	18 25 to 18 50	16 75 to 17 75	15 00 to 15 50	10 75 to 11 25
10 to 11	9½ to 10	11½ to 12½	13 to 13½	12½ to 13½	13½ to 14	10½ to 12½
13 to 16	12¼ to 15½	13¼ to 15¼	14½ to 16	13 to 16	....	....
8½ to 8¾	8 to 8½	8 to 8½	7½	....	8	7¾
12 00 to 15 00	12 00 to 15 00	....	....	10 00 to 12 00	10 00 to 12 00	10 00 to 12 00
22 to 24	18 to 21	18 to 21	20 to 22	25 to 30	25 to 31	24 to 26
15 to 20	10 to 17	10 to 17	15 to 17	18 to 24	16 to 25	15 to 22

MARKET PRICES OF FAR

Product.	January.	February.	March.	April.	Ma.
St. Louis—Continued.					
Cheese:					
Creamery ....lb	$0 11 to $0 13	$0 12 to $0 14	$0 12 to $0 15	$0 13 to $0 15	....
Lower grades......... do	9 to 10	8 to 9	9 to 10	10 to 11	....
Eggs ....doz	20	32 to 33	18 to 18½	13 to 14½	$0 10½ to $0
Tobacco:					
Common to good lugs, burley. ....cental	6 00 to 8 00	6 00 to 8 00	6 50 to 7 50	6 50 to 7 50	7 00 to 7
Common to medium leaf, burley.......... cental	8 50 to 13 00	8 15 to 13 00	9 50 to 11 00	9 50 to 11 00	12 00 to 1
Good to fine leaf ......do	....	14 00 to 20 00	18 00 to 20 00	....	....
Wool:					
Tub-washed, choice. ..lb.	34	33½	33 to 34	34 to 34½	33½ to
Unwashed, medium .. do	24 to 24½	23	23 to 24	23	23½ to
Peanuts, white ....do	5½ to 6	5½ to 6	5½ to 6½	6½ to 7½	7 to
Cotton:					
Ordinary to good ordinary ....lb.	8½ to 9⅛	8⅞ to 9½	8 13/16 to	9 7/16	9¼ to 10⅛	9¾ to
Low middling to good middling ....lb.	9⅞ to 10⅞	10 to 10¾	10 to 10½	10¾ to 11⅛	11½ to
Apples ....bbl.	....	....	....	....	....
Kansas City.					
Flour:					
Choice..............*sack.	1 75 to 1 80	1 70 to 1 80	2 00 to 2 10	2 00 to 2 15	2 00 to 2
Fancy ....do.	2 10 to 2 20	2 05 to 2 15	2 25 to 2 30	2 25 to 2 35	2 25 to 2
Wheat:					
No. 1 red winter....bush.	....	1 03	1 03	....	....
No. 2 red winter ......do	81 to 82¾	80	96⅛	82½	84½
Corn, No. 2 mixed ......do	37¾ to 38⅛	....	40½ to 40⅞	42 to 42¾	42⅞
Rye, No. 2...............do.	46½ to 47	49	48	50	52
Oats, No. 2...............do.	26¾	28¼	29½ to 30¼	29 to 29½	31
Potatoes..................do.	35 to 50	35 to 50	30 to 50	33 to 52	30 to
Hay, baled ....ton.	8 50 to 9 00	7 50 to 8 50	7 00 to 9 00	7 50 to 9 00	10 00 to 1
Pork:					
Mess ....bbl.	14 00	15 50	19 50	19 00	17 50
Clear ....do	17 00	21 50	24 50	24 00	19 50
Hams, sugar-cured....lb.	14	13	13¼	13½	13
Bacon, breakfast .....do	14	11	12¼	8¾	11½
Lard, tierce..............do.	9¼ to 9⅞	9¼	9¾	9½	8¾
Butter:					
Creamery...............do.	28 to 33	28 to 33	25 to 30	27 to 31	25 to
Dairy....................do.	23 to 24	18 to 25	18 to 24	20 to 26	18 to
Cheese:					
Full cream.............do	13 to 14	14½ to 15	15½	14 to 15½	16½
Eggs ....doz	19 to 20	25 to 26	17	15	10
Peanuts..................lb.	5 to 6	8 to 9	8 to 9	10 to 12½	10½ to
Wool:					
Unwashed ....do	....	17 to 23	....	....	14 to
Tub-washed ....do.	....	28 to 33	....	....	28 to
Apples:	....	....			
Consigned .... bbl	....	....	....	....	3 00 to 4
Home grown. ......bush	....	....	....	....	1 00 to 1
New Orleans.					
Flour:					
Family ....bbl	4 00 to 4 50	4 00 to 4 50	4 50	4 70 to 5 00	4 25 to 4
Minnesota patents ...do	5 50 to 7 00	6 75 to 7 00	6 50 to 7 00	6 50 to 6 73	....
Wheat:					
No. 2 red winter ...bush	1 12½	1 06½ to 1 10	1 06½ to 1 10	1 10	1 10
Corn, No. 2..............do	55 to 56	57 to 60	57 to 58	56 to 57	58 to
Oats, Western .... do	45 to 46	46 to 45½	47 to 48	43 to 44	44½ to
Potatoes.................bbl	1 15 to 1 60	1 40 to 1 70	1 70 to 1 75	1 30 to 1 75	3 50 to 4
Hay:					
Prime..................ton.	14 00 to 14 50	14 00 to 15 00	17 00	12 00 to 13 00	18 00 to
Choice.................do	15 00	17 00 to 18 00	18 50	18 00 to 19 00	24 00 to
Beef:					
Western .... bbl	12 50 to 14 50	14 00 to 14 50	12 50 to 13 00	14 00 to 14 50	13 00 to 14
Fulton market......½ bbl	9 00	9 25	9 00 to 9 50	9 75 to 10 00	9 50
Pork:					
Mess.............. ...bbl	15 25	18 37½ to 18 50	18 25	19 00	17 50 to 17
Bacon, sugar-cured .. lb	9½ to 10	10¼ to 10½	11 to 11½	11 to 11¾	11½ to
Hams, sugar-cured....do.	13¼ to 14	12½ to 13½	13 to 13½	13½	13½ to
Lard.....................do	8¾ to 10	9½	9¾	9⅝	8¼ to
Butter:					
Western creamery....lb.	25 to 43	26 to 40	26 to 37	21 to 36	20 to
Western dairy........do.	8 to 30	10 to 30	17 to 27	15 to 28	18 to

*One-fourth barrel, 49 lbs.

PRODUCTS FOR 1884—Continued.

June.	July.	August.	September.	October.	November.	December.
$0 08 to $0 10	$0 07 to $0 00	$0 09 to $0 09½	$0 10 to $0 10½	$0 11 to $0 12	$0 11 to $0 12	$0 08 to $0 13½
7 to 9	......	......	8 to 10	8 to 9	8 to 10	7 to 9
10 to 11	10 to 10½	8½ to 10½	12½	16	18	22
7 00 to 9 00	6 50 to 7 50	6 50 to 7 50	6 50 to 7 50	6 50 to 7 50	6 50 to 7 50	6 00 to 7 00
8 00 to 12 00	8 50 to 10 00	10 00 to 12 00	8 50 to 10 00	8 50 to 12 00	8 50 to 10 00	10 00 to 12 00
11 00 to 14 00	......	......	......	......	......	......
31 to 33	30	29	30 to 30½	29	27 to 28	23 to 28
21 to 22	20 to 20½	20 to 20½	21 to 21½	20 to 20½	20 to 20¼	10
6 to 8	6¾ to 7	6 to 7	5 to 5½	5 to 5½	5 to 5¼	3 to 4
9½ to 10⅜	8⅜ to 9¾	8⅜ to 9½	8¼ to 8⅝	7⅜ to 8⅞	8 3/16 to 8 13/16	8⅛ to 9¼
11⅛ to 11⅝	10⅜ to 11¼	10⅜ to 11	10⅛ to 10⅞	9⅜ to 9⅞	9 1/16 to 9⅜	9⅜ to 10¼
1 60 to 3 00	1 50 to 3 00	1 00 to 2 50	1 50 to 2 25	1 50 to 2 55	1 00 to 2 10	2 00 to 2 75
2 05 to 2 15	2 00 to 2 15	2 15 to 2 25	1 50 to 1 60	1 50 to 1 55	1 30 to 1 35	1 30 to 1 35
2 35 to 2 40	2 30 to 2 40	2 40 to 2 65	1 70 to 1 80	1 70 to 1 75	1 40 to 1 50	1 35 to 1 40
......	......	......	......	......	......	......
83½	70 to 73½	69½ to 69½	63 to 63¼	59½	52½ to 53	52 to 53⅛
44¾ to 45	42¼ to 42¾	42⅛ to 42¼	41	48½	30⅛ to 31	31
	47¼	......	41	40 to 41	40	41
29¼	26 to 26¾	23 to 25	23 to 24	27	22	23
35 to 60	25 to 50	50 to 60	50 to 65	40 to 55	30 to 40	35 to 40
8 00 to 9 50	8 50 to 11 00	7 50 to 9 00	7 00 to 8 00	7 00 to 8 00	7 00 to 8 00	7 50 to 8 25
17 50	17 50	17 50	18 50	17 50	17 50	17 50
19 50	......	22 00	23 00	22 00	22 00	21 75
13	14	14	14½	13	12½	12½
11¾	8 to 10	7½	13½	13½	13½	13
8½	8 to 9	8	8½	8	8	8½
15 to 19	15 to 17	15 to 19	17 to 20	18 to 22	28 to 30	29 to 32
10 to 15	9 to 12	10 to 14	10 to 12	14 to 16	20 to 23	25 to 26
13 to 15	9 to 10	10 to 10½	11½ to 12	12 to 13	13½	......
10½	......	7 to 9	11½	14	21	22
10½ to 12½	......	......	......	......	......	......
15 to 22	12 to 22	12 to 22	13 to 22	13 to 22	13 to 22	13 to 23
25 to 34	25 to 32	25 to 32	27 to 31	27 to 31	27 to 31	25 to 31
......	......	......	1 25 to 1 50	1 25 to 2 00	1 00 to 2 00	1 25 to 2 25
......	......	75 to 1 50	35 to 50	35 to 50	35 to 50	35 to 60
4 25 to 4 50	Nominal.	Nominal.	4 00 to 4 10	Nominal.	Nominal.	Nominal.
6 00 to 6 65	6 00 to 6 50	6 00 to 6 25	6 00 to 6 10	5 75	5 37½ to 5 50	5 37½ to 5 50
1 10	1 00 to 1 10	90 to 93	90	87	87	85
60	59	54	56 to 67	56	54	46 to 47
41½ to 42	41½ to 42	40 to 41	35 to 36½	35	35	34 to 35
70 to 1 35	1 50 to 1 60	1 60 to 2 00	1 60 to 2 15	1 90 to 2 05	1 50 to 1 75	1 45 to 1 85
19 00 to 20 00	14 00 to 16 00	13 50 to 15 00	16 00	14 00 to 15 00	15 00 to 18 00	16 00
21 00 to 23 00	16 00 to 17 00	16 00 to 17 00	17 00 to 17 50	17 00	18 00 to 19 00	18 00
12 50 to 13 50	12 00 to 14 00	12 75 to 13 25	11 00 to 12 00	12 50	11 00	11 50 to 12 00
9 50	9 50	8 50 to 8 75	9 00	9 25	9 25	9 00
17 50	16 00 to 16 50	16 50	18 00	17 50	15 00 to 15 75	12 00 to 12 50
11 to 12	11 to 11½	10½	12 to 12½	12	12	11½
12½ to 13	13 to 13½	14½	15	14 to 15	13 to 15	12 to 13
8½	8¾ to 9¼	7¼ to 8¾	8	8 to 8¼	7¼ to 8¼	7½ to 7⅞
17 to 23	20 to 22	20 to 23	16 to 22	18 to 33	26 to 33	22 to 31
14 to 17	15 to 17	14 to 17	13 to 18	12 to 20	18 to 24	15 to 22

*Unusual speculative demand for this grade at this date.

†New.

MARKET PRICES OF FARM

Product.	January.	February.	March.	April.	May.
New Orleans—Continued.					
Cheese:					
New York cream ..... do.	$0 14½ to $0 15	$0 15½	$0 14 to $0 15½	$0 16	$0 16½ to $0 1
Western cream .... do.	12½ to 18	12½ to $0 13	12 to 12½	....	....
Eggs .... doz.	26 to 28	31 to 33	11 to 16	17 to $0 19	14 to 16
Sugar:					
Fully fair .... lb.	5½	5½	5⅜ to 5½	5¾	5⅝
Strictly primo .... do.	5⅝	5⅝ to 5⅞	5⅜ to 5¾	5⅞	5⅞
Clarified (white) ...... do.	7⅛ to 7¼	7⅛ to 7¼	7	6⅞ to 7	6⅞ to 6
Cotton:					
Low ordinary .... do	....	7½ to 7¾	....	7⅝ to 8	8⅛ to 8
Ordinary to good ordinary .... lb.	8⅝ to 9⅜	8 9/16 to 9 11/16	8½ to 9⅝	8 13/16 to 10 1/16	9½ to 10
Low middling to good middling .... lb.	9⅝ to 10⅜	10 to 10 11/16	10⅛ to 10 13/16	10⅝ to 11 5/16	11¼ to 11
Middling fair .... do.	10⅜ to 10⅞	10 13/16 to 10 15/16	10 13/16 to 10 15/16	11 7/16 to 11 9/16	12 1/16 to 12
Tobacco:					
Lugs .... lb.	6½ to 7½	6⅛ to 7½	6½ to 7⅛	6½ to 7⅛	8 to 9
Common to medium leaf .... lb.	7½ to 9	6½ to 8	7½ to 9	7½ to 9	9 to 1
Good leaf .... do.	Nominal.	Nominal.	Nominal.	Nominal.	11 to 12
Peanuts .... do.	9 to 10½	7 to 10	7 to 10	....	....
Rice, cleaned:					
Common .... do.	4¼ to 4⅞	4 to 4 7/16	4 to 4½	4½ to 4½	4½ to 4
Good .... do.	5½ to 5¾	5½ to 5¾	5⅜ to 5⅝	4⅞ to 5⅛	5⅛ to 5
Apples .... bbl.	....	....	....	....	....
SAN FRANCISCO.					
Flour:					
Superfine .... bbl.	4 00 to 4 50	3 25 to 4 25	4 00 to 4 50	4 20 to 4 30	4 00 to 4 5
Extras .... do.	5 25 to 5 75	5 12½ to 5 75	5 25 to 5 75	5 25 to 5 65	5 00 to 5 25
Wheat:					
No. 1 white .... cental.	1 77½ to 1 80	1 72½ to 1 75	1 60 to 1 67½	1 57½ to 1 60	....
No. 2 .... do.	1 70 to 1 78	1 67½ to 1 70	1 58 to 1 61	....	....
Barley .... do.	1 02½ to 1 17½	1 02½	90 to 1 30	85 to 1 30	75 to 7
Corn:					
White .... do.	1 65 to 1 70	1 50 to 1 55	1 45 to 1 50	1 45 to 1 50	1 45 to 1 5
Yellow .... do.	1 55 to 1 65	1 55 to 1 60	1 60 to 1 65	1 60 to 1 65	1 60 to 1 6
Oats .... do.	1 50 to 1 75	1 50 to 1 85	1 10 to 1 45	1 35 to 1 80	1 35 to 1 6
Potatoes .... bush.	45 to 95	60 to 1 10	75 to 90	40 to 1 50	1 00 to 1 50
Hay:					
Wheat .... ton.	13 00 to 15 00	15 00 to 16 00	11 00 to 13 50	11 00 to 13 00	11 00 to 13 00
Other varieties .... do.	9 00 to 15 00	14 00 to 16 00	8 00 to 13 00	8 00 to 12 50	6 00 to 12 50
Beef:					
Mess .... bbl.	15 00 to 15 50	15 25	15 00 to 15 50	15 50	15 50
Family .... do.	17 00 to 18 00	17 00 to 18 00	17 00 to 18 50	18 00 to 18 50	18 00 to 18 50
Pork:					
Mess .... do.	24 50 to 25 00	24 50 to 25 00	24 50 to 25 00	24 50 to 25 00	24 50 to 25 00
Breakfast bacon, Eastern .... lb.	15½ to 16	13½ to 14¼	15½ to 16	15½ to 16	15½ to 16
Hams, California ...... do.	15 to 16	14½ to 15	14 to 15	14 to 16	14 to 16
Lard, in tierces .... do.	15	12½ to 12¾	15	15	15
Butter:					
Fancy .... do.	35	32½	35	24 to 25	23
Choice roll .... do.	30 to 32½	30 to 31	32½	21 to 23	21 to 2
Cheese:					
New York factory .... do	17 to 18	17 to 18	17 to 18	17 to 18	20
California, factory .... do.	15 to 18	17 to 18	16 to 16½	16 to 18	....
Eggs, California .... doz.	35 to 40	25 to 30	25	21 to 22	19 to 2
Wool:					
Eastern Oregon .... lb.	20 to 22	20 to 22	20 to 22	20 to 22	....
San Joaquin and middle county .... lb.	16 to 19	16 to 10	16 to 19	16 to 19	12 to 16
Apples .... box.	....	....	....	....	1 00 to 3 00

PRODUCTS FOR 1884—Continued.

June.	July.	August.	September.	October.	November.	December.
$0 15 to $0 15½	$0 13	$0 12	$0 12½ to $0 13	$0 12½ to $0 13	$0 13	$0 14½
....	9	7	9	12½ to 13	15	16
15 to 16	12 to $0 18	10 to $0 12	14 to 18	19 to 24	20 to $0 25	27 to $0 30
5¼ to 5⅜	4½	4⅞	4½ to 4⅝	4½	....	3⅝ to 3 11/16
5⅛ to 5⅞	4¾	5¼	5	6⅛	....	3⅞ to 3 15/16
6⅛ to 6⅜	5⅞	6⅛	....	....	....	....
7⅞ to 8	7⅝	7½	7⅜	7	7 7/16	7 9/16
9¼ to 10⅜	9 to 10	8⅞ to 9⅞	8 5/16 to 10	8⅜ to 9⅜	8 1/16 to 9 1/16	8 9/16 to 9 7/16
11 to 11⅜	10⅝ to 11	10⅜ to 10 15/16	10½ to 10⅞	9⅜ to 10	9⅜ to 9 13/16	9 15/16 to 10 7/16
11⅞ to 12	11½	11 3/16	11	10½	10⅛	10 9/16
8 to 9	8 to 9	8 to 9	8 to 9	8 to 9	8 to 9	8 to 9
9 to 10	9 to 10	9 to 10	9 to 10	9 to 10	9 to 10	9 to 10
11 to 12	11 to 12	11 to 12	11 to 12	11 to 12	11 to 12	11 to 12
....	....	9 to 12	5 to 9	5 to 9	4 to 8	4 to 8
4½ to 5	4¼ to 4⅝	4⅛ to 4⅞	4 to 4½	4¾ to 4⅞	4 to 4⅜	4 to 4¼
5⅝ to 5¾	5⅜ to 5⅞	5⅛ to 5⅝	5¼ to 5⅜	5¼ to 5⅜	5¼ to 5½	5¼ to 5⅝
....	....	3 25 to 3 75	1 00 to 3 00	1 50 to 4 50	1 00 to 3 25	1 75 to 4 00
2 75 to 3 50	4 00 to 4 50	3 00 to 3 50	4 00 to 4 50	2 50	2 50	2 25 to 2 50
4 25 to 4 75	5 00 to 5 25	4 50 to 5 30	5 00 to 5 25	4 75	4 75	4 50
....	1 42½ to 1 45	1 42½ to 1 45	1 25	1 22 to 1 30	1 25	1 23
....	....	....	1 22½ to 1 25	....	....	....
77½ to 1 25	....	....	80 to 90	82½ to 1 02½	1 12½ to 1 50	90
1 55 to 1 60	....	1 55 to 1 62½	1 55 to 1 60	1 45 to 1 52½	1 25	1 25
1 60 to 1 67½	....	1 55 to 1 65	1 55 to 1 60	....	1 25	1 25
1 37½ to 1 70	....	1 20 to 1 30	1 20 to 1 35	1 12½ to 1 45	1 10 to 1 50	1 12½
1 25 to 2 00	75 to 1 00	40 to 80	40 to 75	80 to 90	70 to 85	90 to 1 00
11 00 to 12 50	Nominal.	16 00 to 16 50	16 00 to 17 00	15 00 to 16 00	12 00 to 16 00	14 00 to 16 00
9 00 to 12 00	....	10 00 to 14 00	10 00 to 17 00	....	10 00 to 16 00	9 00 to 14 00
14 00 to 15 00	14 00 to 15 00	....	....	....	....	....
18 00 to 18 50	18 00 to 18 50	....	....	....	....	....
24 50 to 25 00	24 50 to 25 00	24 40 to 25 00	....	....	....	....
14½ to 15½	14 to 15	13½ to 15	14 to 15	15 to 15½	14 to 14½	14 to 14½
14½	15½ to 16	15½ to 16	14 to 17	16½ to 17	16½ to 17	16 to 17
12 to 13½	12 to 13	11½ to 12	11½ to 13	12 to 13	10½ to 12	11 to 13
23	24	24 to 25	32½	40	37½ to 40	38 to 42
21 to 22	21 to 23½	21 to 23	27½ to 30	35 to 37½	35 to 37½	36 to 38
20	20 to 21	17 to 18	17 to 18	16½ to 17	16½ to 17	16
....	9 to 11	10 to 12½	10 to 13	10 to 12½	10 to 13	12 to 14
21 to 22	22 to 24	27½ to 28	25 to 34	35 to 42½	35 to 42½	36 to 40
16 to 20	16 to 20	16 to 20	16 to 20	15 to 18	15 to 18	14 to 18
14 to 18	14 to 18	14 to 18	14 to 18	7 to 10	7 to 9	7 to 9
1 00 to 3 00	50 to 1 00	40 to 1 00	40 to 1 00	25 to 75	40 to 1 25	50 to 1 25

LIVE-STOC

Product.	January.	February.	March.	April.	May.
PHILADELPHIA.					
Cattle:					
Common to choice beeves, cental	$5 00 to $7 50	$5 25 to $7 25	$5 00 to $7 25	$4 50 to $7 00	$5 00 to
Milch cows ....head	30 00 to 60 00	30 00 to 65 00	30 00 to 70 00	35 00 to 65 00	30 00 to
Sheep................cental.	3 00 to 5 50	3 50 to 5 75	4 00 to 6 50	5 50 to 7 00	4 25 to
Swine..................do..	8 00 to 8 75	8 00 to 9 25	9 50 to 10 75	8 00 to 10 50	8 50
KANSAS CITY.					
Cattle:					
Native cows ......cental.	3 40 to 4 25	3 55 to 3 87½	3 00 to 4 90	4 50 to 5 00	4 00 to
Native steers ....do..	4 50 to 4 95	4 00 to 4 70	4 25 to 5 15	4 65 to 5 25	4 15 to
Native shippers .....do..	5 30 to 5 75	4 45 to 5 90	5 25 to 6 20	5 20 to 5 75	5 15 to
Swine..................do..	4 50 to 5 40	5 85 to 6 35	6 30 to 6 50	5 00 to 6 70	5 20 to
Sheep..................do..	1 25 to 3 00	1 75 to 4 50	3 00 to 4 50	3 70 to 5 20	5 00
NEW ORLEANS.					
Cattle:					
Texan, good to smooth fat ....cental.	4 00 to 5 25	4 00 to 5 50	5 00 to 6 00	4 00 to 6 00	4 00 to
Grass-feed..........head.	16 00 to 30 00	16 00 to 24 00	16 00 to 24 00	18 00 to 25 00	18 00 to
Milch cows ....do..	25 00 to 100 00	25 00 to 100 00	25 00 to 100 00	25 00 to 100 00	25 00 to 100
Calves ....do..	6 00 to 10 00	6 00 to 10 00	5 00 to 10 00	6 00 to 10 00	6 00 to 10
Sheep..................do..	1 50 to 3 50	2 00 to 3 50	1 50 to 3 50	1 50 to 3 50	1 50 to
Swine...............cental.	4 00 to 6 00	4 00 to 7 00	4 00 to 7 00	4 00 to 7 50	4 00 to
Horses:					
Common work ......head.	60 00 to 85 00	60 00 to 85 00	60 00 to 85 00	60 00 to 85 00	60 00 to 85
Good work.............do..	80 00 to 125 00	80 00 to 125 00	80 00 to 125 00	90 00 to 125 00	80 00 to 125
Saddle and harness ..do..	175 00 to 200 00	175 00 to 200 00	175 00 to 200 00	175 00 to 200 00	175 00 to
Mules ....do..	125 00 to 225 00	125 00 to 225 00	125 00 to 225 00	125 00 to 225 00	125 00 to
BOSTON.					
Cattle:					
Premium bullocks.cental.	6 87½ to 8 00	7 50 to 10 50	10 00	6 75 to 8 50	9 00 to
Milch cows.........head.	20 00 to 75 00	20 00 to 75 00	30 00 to 80 00	30 00 to 65 00	35 00 to 55
Sheep...............cental.	5 50 to 6 50	2 75 to 5 00	2 75 to 6 00	5 00 to 5 75	5 00 to
Swine ....do..	5 25 to 6 50	6 25 to 7 00	7 00 to 8 00	7 00 to 7 87½	6 87½ to
CHICAGO.					
Cattle:					
Extra beeves......cental.	7 00 to 7 25	7 00 to 7 50	7 25	6 50 to 6 60	
Choice beeves. ......do..	6 30 to 6 40	6 00 to 6 25	6 75 to 7 10	6 20 to 6 40	6 15 to
Good beeves ......do..	....	6 00 to 6 50	6 30 to 6 65	5 75 to 6 00	....
Medium beeves......do..	....	5 00 to 6 00	5 75 to 6 25	5 25 to 5 60	5 25 to
Veals ....do..	....	4 00 to 7 00	4 00 to 7 75	4 00 to 7 00	....
Sheep..................do..	3 50 to 5 25	5 00 to 5 75	5 00 to 6 00	5 00 to 5 60	4 80 to
Swine..................do..	5 00 to 6 00	5 00 to 6 75	6 00 to 7 50	6 00 to 6 70	5 30 to
CINCINNATI.					
Cattle:					
Choice to extra shipping steers (gross).. cental.	5 75 to 6 25	5 75 to 6 40	6 00 to 6 50	6 00 to 6 35	6 00 to
Fair to good shipping steers (gross) ...cental.	4 75 to 5 50	4 75 to 5 50	5 00 to 5 75	5 50 to 5 85	5 50 to
Good to choice butchers' grades (gross)... cental	4 75 to 5 25	4 75 to 5 65	3 75 to 5 85	5 50 to 6 00	5 50 to
Fair to medium butchers' grades (gross).. cental.	3 25 to 4 50	3 50 to 4 50	3 75 to 4 75	4 00 to 5 25	4 25 to
Good to extra fat cows and heifers (gross)...cental	4 25 to 5 00	4 50 to 5 50	4 50 to 5 60	5 00 to 5 75	5 00 to
Sheep..................do..	2 50 to 5 25	3 75 to 4 50	2 50 to 6 00	3 00 to 6 00	3 75 to
Swine (gross)..........do.	5 20 to 5 80	5 80 to 6 40	5 65 to 7 40	6 00 to 7 00	4 30 to
SAINT LOUIS.					
Cattle:					
Export steers .....cental	6 33 to 6 60	6 40 to 6 75	6 50 to 7 00	6 25 to 6 60	6 35 to
Good to heavy steers.do..	5 75 to 6 25	5 90 to 6 25	6 00 to 6 40	5 80 to 6 15	6 00 to
Fair to good steers ..do..	4 00 to 5 60	4 50 to 5 90	4 85 to 6 00	4 85 to 6 00	5 00 to
Milch cows (with calves) ....head	25 00 to 50 00	25 00 to 50 00	25 00 to 50 00	23 00 to 50 00	23 00 to
Sheep:					
Good to choice muttons ....cental.	4 25 to 5 00	4 75 to 6 00	5 50 to 6 00	4 75 to 6 00	5 00 to
Medium to fair muttons.............cental.	3 50 to 4 00	3 40 to 3 80	3 25 to 3 75	3 50 to 4 60	4 00 to

MARKETS.

June.	July.	August.	September.	October.	November.	December.
$6 75 to $9 00	$6 75 to $8 00	....	....	....	....	....
25 00 to 80 00	25 00 to 75 00	....	....	....	....	....
2 75 to 6 75	2 25 to 6 50	....	....	....	....	....
6 25 to 6 75	6 00 to 6 50	....	....	....	....	....
4 00 to 4 85	2 75 to 4 50	$2 00 to $3 20	$2 50 to $3 30	$2 50 to $3 25	$2 90 to $3 50	$3 00 to $3 50
5 25 to 6 10	....	4 60 to 5 05	....	3 10 to 4 10	2 60 to 3 65	2 75 to 3 75
6 15 to 6 40	5 15 to 5 70	5 00 to 5 75	....	....	4 75 to 5 00	4 80 to 5 15
5 00 to 5 10	4 25 to 5 00	4 85 to 5 55	5 85 to 6 25	4 50 to 5 45	4 40 to 4 70	4 30 to 4 50
4 25	....	....	....	....	2 12½ to 2 30	2 15 to 2 25
4 00 to 6 00	4 00 to 5 50	3 50 to 4 50	....	....	4 00 to 4 50	4 50 to 5 00
18 00 to 25 00	18 00 to 25 00	18 00 to 25 00	....	....	18 00 to 25 00	15 00 to 23 00
25 00 to 80 00	25 00 to 100 00	20 00 to 60 00	....	....	20 00 to 75 00	20 00 to 75 00
6 00 to 10 00	6 00 to 10 00	4 00 to 8 00	....	....	4 00 to 8 00	4 00 to 8 00
1 50 to 3 50	1 50 to 3 50	1 50 to 3 50	....	....	1 50 to 3 00	1 50 to 3 00
4 00 to 6 50	4 00 to 6 50	4 00 to 6 50	....	....	3 00 to 6 00	4 00 to 6 50
60 00 to 85 00	60 00 to 85 00	60 00 to 85 00	....	....	60 00 to 85 00	60 00 to 85 00
85 00 to 125 00	80 00 to 125 00	80 00 to 125 00	....	....	80 00 to 125 00	80 00 to 125 00
175 00 to 200 00	175 00 to 200 00	175 00 to 200 00	....	....	175 00 to 200 00	175 00 to 200 00
125 00 to 225 00	125 00 to 225 00	125 00 to 225 00	....	....	125 00 to 225 00	125 00 to 225 00
6 75 to 9 50	7 25 to 7 50	6 00 to 7 50	7 00 to 9 00	....	10 00 to 10 25	....
25 00 to 80 00	30 00 to 80 00	30 00 to 75 00	30 00 to 75 00	....	35 00 to 60 00	....
2 75 to 6 75	....	2 75 to 5 00	2 50 to 4 75	....	4 50 to 5 75	....
6 25 to 6 75	5 75 to 6 00	5 75 to 6 00	6 50	....	5 75 to 6 25	....
6 85 to 7 25	6 00 to 6 75	6 80 to 6 87½	7 05	Nominal.	6 60 to 6 75	6 60 to 6 75
6 25 to 6 60	5 75 to 6 00	6 40 to 6 60	6 40 to 6 50	6 50 to 6 85	6 10 to 6 50	6 00 to 6 40
....	5 00 to 5 50	6 25 to 6 50	6 00 to 6 50	5 75 to 6 25	5 25 to 5 85	5 50 to 5 75
5 40 to 5 75	4 50 to 5 00	6 00 to 6 25	6 00 to 6 15	4 50 to 5 25	4 50 to 5 00	4 25 to 5 00
....	4 00 to 7 25	....	....	4 50 to 7 50	4 50 to 7 25	4 50 to 7 50
3 00 to 5 50	3 00 to 4 25	2 75 to 4 50	2 75 to 4 00	2 25 to 4 40	2 00 to 4 50	2 00 to 3 75
4 90 to 5 50	5 30 to 5 80	5 40 to 6 00	5 75 to 6 75	4 70 to 5 90	4 25 to 5 00	4 10 to 4 35
6 25 to 6 50	6 25 to 6 50	6 00 to 6 25	5 75 to 6 50	5 50 to 6 25	5 50 to 6 00	5 75 to 6 00
5 75 to 6 00	5 50 to 6 00	5 25 to 5 75	5 00 to 5 50	4 50 to 5 25	4 50 to 5 25	4 75 to 5 50
5 75 to 6 15	5 25 to 5 75	4 75 to 5 25	4 50 to 5 00	4 25 to 4 65	4 00 to 4 60	4 25 to 4 75
4 25 to 5 50	4 00 to 5 00	3 50 to 4 50	3 25 to 4 25	2 75 to 4 00	2 75 to 3 75	2 75 to 4 00
5 00 to 5 85	5 00 to 5 50	4 50 to 5 00	4 00 to 4 75	3 75 to 4 50	3 75 to 4 40	3 75 to 4 60
3 00 to 5 25	3 00 to 4 75	3 00 to 4 75	2 25 to 4 25	2 25 to 4 25	2 25 to 4 25	2 25 to 4 75
4 00 to 5 65	4 00 to 4 30	4 50 to 5 80	5 50 to 6 60	4 75 to 5 50	3 50 to 5 00	3 40 to 4 50
6 40 to 6 75	6 60 to 6 75	6 25 to 6 60	6 30 to 6 65	6 50 to 6 65	6 00 to 6 50	5 25 to 6 75
6 10 to 6 80	6 35 to 6 50	6 00 to 6 20	5 50 to 6 25	5 75 to 6 40	5 00 to 5 85	5 25 to 6 15
5 00 to 6 30	5 40 to 6 15	5 00 to 5 75	4 00 to 5 40	4 35 to 5 50	4 35 to 4 75	4 40 to 5 00
23 00 to 50 00	23 00 to 45 00	23 00 to 45 00	23 00 to 45 00	28 00 to 45 00	23 00 to 45 00	23 00 to 45 00
5 00 to 6 00	3 75 to 4 50	3 25 to 3 75	3 25 to 3 75	3 25 to 3 65	3 25 to 3 85	3 15 to 3 35
3 80 to 4 40	3 00 to 3 50	2 65 to 3 00	2 50 to 3 00	2 65 to 3 00	2 75 to 3 15	2 25 to 3 00

LIVE-STOCK

Product.	January.	February.	March.	April.	May.
SAINT LOUIS—Continued.					
Swine, common to good packing .... cental.	$5 35 to $5 60	$5 80 to $6 30	$6 25 to $6 75	$6 30 to $6 65	$5 40 to $
Horses:					
Streeters .... head.	....	....	110 00 to 140 00	110 00 to 140 00	130 00 to 15
Draft .... do..	....	....	150 00 to 225 00	150 00 to 225 00	100 00 to 1
Saddlers .... do..	....	....	110 00 to 170 00	110 00 to 170 00	140 00 to
Mules:					
14 to 14½ hands .... do..	....	....	90 00 to 110 00	90 00 to 110 00	110 00 to 1
15 to 15½ hands .... do..	....	....	110 00 to 130 00	110 00 to 150 00	165 00 to 2
15½ to 16 hands .... do..	....	....	150 00 to 180 00	150 00 to 180 00	....
NEW YORK.					
Cattle:					
Best beeves .... cental.	11 50 to 12 25	12 50 to 13 25	10 00 to 12 50	12 25 to 12 75	12 00 to 1
Common to good ..... do..	9 25 to 11 50	10 75 to 12 50	....	11 25 to 12 00	11 00 to 1
Milch cows .... head..	35 00 to 65 00	35 00 to 65 00	40 00 to 60 00	30 00 to 60 00	30 00 to 6
Veal calves .... cental.	6 75 to 10 25	5 50 to 9 75	7 00 to 10 00	6 00 to 9 00	6 50 to
Sheep .... do..	4 00 to 6 00	6 50 to 7 00	5 00 to 6 75	5 85 to 6 75	5 75 to
Swine .... do..	5 50 to 5 75	6 00 to 6 55	8 75 to 9 00	....	....
BALTIMORE.					
Cattle:					
Best beeves .... cental.	5 75 to 6 50	6 37 to 6 90	6 50 to 6 85	6 00 to 6 55	5 75 to
First quality	4 50 to 5 50	5 25 to 6 00	5 37 to 6 12	4 75 to 6 55	5 00 to
Medium	3 75 to 4 25	3 75 to 5 00	4 00 to 5 25	3 62 to 4 50	4 00 to
Swine (net) .... cental.	7 00 to 8 00	7 25 to 9 25	8 00 to 9 75	8 00 to 9 50	7 00 to
Sheep (gross) .... do..	3 00 to 5 50	3 00 to 6 25	5 00 to 6 50	4 00 to 6 63	5 00 to

MARKETS—Continued.

June.	July.	August.	September.	October.	November.	December.
$5 00 to $5 10	$4 75 to $5 10	$5 20 to $5 50	$5 80 to $6 20	$5 10 to $5 50	$4 55 to $4 50	$5 15 to $4 50
120 00 to 140 00	125 00 to 140 00	120 00 to 140 00	115 00 to 140 00	90 00 to 200 00	90 00 to 130 00	90 00 to 130 00
100 00 to 200 00	140 00 to 225 00	130 00 to 200 00	125 00 to 200 00	125 00 to 200 00	115 00 to 175 00	115 00 to 175 00
140 00 to 230 00	135 00 to 225 00	130 00 to 200 00	125 00 to 200 00	125 00 to 200 00	110 00 to 175 00	90 00 to 175 00
110 00 to 120 00	100 00 to 125 00	110 00 to 120 00	95 00 to 110 00	90 00 to 115 00	75 00 to 105 00	85 00 to 90 00
170 00 to 200 00	130 00 to 180 00	135 00 to 200 00	115 00 to 150 00	120 00 to 165 00	105 00 to 145 00	110 00 to 150 00
160 00 to 180 00	170 00 to 190 00	175 00 to 200 00	105 00 to 200 00	125 00 to 165 00	145 00 to 175 00	150 00 to 180 00
12 25 to 13 50	12 30 to 13 00	12 00 to 12 50	9 00 to 12 50	12 25 to 12 50	12 25 to 12 50	8 50 to 12 50
11 00 to 12 75	10 75 to 12 00	10 00 to 12 00	8 00 to 9 75	8 75 to 12 00	8 00 to 12 00	7 50
35 00 to 65 00	35 00 to 55 00	35 00 to 50 00	40 00 to 60 00	35 00 to 60 00	35 00 to 60 00	30 00 to 60 00
5 75 to 7 25	5 75 to 7 50	5 50 to 7 25	6 50 to 9 00	6 25 to 9 50	6 00 to 9 00	6 00 to 9 25
4 50 to 6 50	5 75 to 6 00	5 50 to 6 00	3 00 to 5 00	3 50 to 5 00	3 25 to 5 00	3 00 to 5 00
....	....	....	....	....	....	....
6 50 to 7 00	6 50 to 6 87	5 75 to 6 00	5 75 to 6 00	5 50 to 6 00	5 00 to 5 50	4 00 to 5 25
5 50 to 6 50	5 35 to 6 37	5 37 to 5 62	5 00 to 5 62	4 88 to 5 50	4 00 to 5 00	3 00 to 5 00
4 50 to 5 37	4 50 to 5 50	3 50 to 4 37	3 50 to 4 62	3 00 to 4 50	3 00 to 4 25	....
7 00 to 7 75	6 25 to 7 75	7 50 to 8 00	6 75 to 9 00	6 00 to 8 00	6 00 to 7 50	5 25 to 6 50
3 00 to 5 25	3 00 to 5 00	3 00 to 4 50	2 25 to 4 25	2 25 to 4 50	2 25 to 4 25	2 25 to 4 25

FREIGHT RATES OF 1884.

In accordance with the requirement of Congress, the changes of rates of freight upon agricultural products have been published in each monthly report of this Bureau throughout the year. Not only the through rates from important points of shipment in the North, East, South, and West to large market centers have been accurately shown, but a large array of local rates by rail and water from minor points to local markets.

There have also been published in each monthly report the rates operative upon the first day of each month, showing the cost of transporting to foreign countries our most important products of agriculture. These rates have fluctuated greatly during the past year, caused by the supply and demand or the requirement of ship or shipper. The following tables, A, B, C, D, E, F, and G, show the rates as reported by the several companies operative upon the first day of each month for the 1884:

LAKE RATES.

[Per bushel.]

Months.	Corn.	Wheat.	Rye.	Oats.
June	\$0 2[illegible]	\$ 02[illegible]	\$0 2[illegible]	\$0 1[illegible]
July	1[illegible]	2	1[illegible]	1[illegible]
August	1[illegible]	1[illegible]	1[illegible]	1[illegible]
September	2[illegible]	2[illegible]	2[illegible]	1[illegible]
October	1[illegible]	1[illegible]	1[illegible]	1[illegible]
November	2[illegible]	2[illegible]	2[illegible]	[illegible]

CANAL RATES.

Months.	Corn.	Wheat.	Rye.	Oats.
May	3½	3[illegible]	3[illegible]	[illegible]
June	3[illegible]	3[illegible]	3¼	[illegible]
July	3[illegible]	3[illegible]	3[illegible]	[illegible]
August	3[illegible]	4[illegible]	4[illegible]	[illegible]
September	4[illegible]	4[illegible]	4[illegible]	[illegible]
October	4[illegible]	5	4[illegible]	3[illegible]
November	4[illegible]	4[illegible]	4[illegible]	3

Table showing the rates from Chicago to New York upon certain products, as reported by the several trunk lines upon the first day of each month for the year 1884.

[Per 100 pounds.]

Months.	Cattle.	Horses.	Sheep.	Hogs.	Dressed beef.	Grain.	Flour.	Potatoes.	Tobacco.	Lard.	Pork.	Wool.	Lumber.
January	\$0 60	\$0 60	\$0 60	\$0 35	\$0 64	\$0 30	\$0 30	\$0 35	\$0 37½	\$0 35	\$0 35	\$0 85	\$0 [illegible]
February	60	60	60	35	64	30	30	35	37½	35	35	85	[illegible]
March	60	60	60	35	64	30	30	35	37½	35	35	85	[illegible]
April	60	60	60	20	64	15	30	20	[illegible]	20	20	85	[illegible]
May	60	60	60	20	64	15	15	20	[illegible]	20	20	85	[illegible]
June	50	60	50	20	48	15	15	20	[illegible]	20	20	85	[illegible]
July	30	60	40	25	48	20	20	25	[illegible]	25	25	85	[illegible]
August	30	60	40	30	48	25	25	30	[illegible]	30	30	85	[illegible]
September	20	60	40	30	32	25	25	30	[illegible]	30	30	85	[illegible]
October	20	60	40	30	32	25	25	30	[illegible]	30	30	85	[illegible]
November	20	60	40	30	32	25	25	30	[illegible]	30	30	85	[illegible]
December	20	60	40	30	32	25	25	30	27½	30	30	85	[illegible]

OCEAN STEAMSHIP COMPANIES.

A.—MONARCH LINE—NEW YORK TO LONDON.

Articles.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Wheat .... per bush..	$0 06½	$0 06	$0 05	$0 07½	$0 04	$0 07	$0 08	$0 08½	$0 04½	$0 09	$0 10½	$0 13½
Corn .... do ...	6½	6	5	7½	4	7	8	8½	4½	9	10½	13½
Flour .... per bbl..	48	48	54	48	36	42	42	60	36	48	54	60
Flour (sacks) .... per 2,240 lbs..	3 00	3 60	3 30	3 00	3 00	3 00	3 30	3 60	3 30	3 60	4 20	5 10
Bacon .... do...	6 00	6 00	6 00	6 00	5 40	5 40	5 40	5 40	6 00	5 40	6 00	8 40
Lard .... do...	6 00	6 00	6 00	6 00	5 40	5 40	5 40	5 40	6 60	5 40	6 00	8 40
Cheese .... do...	7 80	7 20	7 20	6 60	7 20	7 20	7 20	8 40	8 40	7 20	7 20	9 60
Tallow .... do...	5 40	6 00	6 00	6 00	5 40	5 40	5 40	5 40	6 00	5 40	6 00	8 40
Beef .... per tierce..	1 20	1 20	1 20	1 20	1 08	1 08	1 08	1 20	1 20	1 08	1 08	1 44
Pork .... per bbl..	78	90	84	84	72	84	84	84	84	72	84	1 62
Oil-cake .... per 2,240 lbs..	3 00	3 00	2 40	2 40	2 70	2 70	2 70	3 60	3 60	3 00	3 60	4 80
Hops .... per lb..	¾	1¼	1¼	¾	1	1½	....	1	1½	....	1	1
Tobacco .... per hhd..	5 40	6 00	6 00	4 80	4 80	6 00	4 80	5 40	4 80	4 80	4 80	7 20
Rosin .... per 280 lbs..	48	48	48	42	42	42	42	66	36	48	48	84
Lard, in small packages .... per 2,240 lbs..	7 20	7 80	7 20	7 20	7 20	7 20	7 20	8 40	8 40	7 20	8 40	9 60
Tobacco, in cases .... per 40 cu. ft..	4 80	4 80	4 80	4 80	4 80	4 80	4 80	4 80	4 80	4 80	4 80	5 40
Measurement per ton .... 40 cu. ft..	4 80	3 60 / 4 80	4 80	4 80	3 60 / 4 80	3 60 / 4 80	4 80	4 80	4 80	4 80	4 80	5 40
Primage .... per cent..	5	....	5	5	5	5	5	5	5	5	5	5

B.—ANCHOR LINE—NEW YORK TO GLASGOW.

Articles.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Wheat .... per bush..	$0 05	$0 08½	$0 05	$0 06	$0 04	$0 06	$0 08	$0 08	$0 06	$0 07	$0 12	$0 14½
Corn .... do ..	5	8½	5	6	4	6	8½	8	6	7	12½	14½
Flour .... per bbl..	36	42	36	30	30	36	36	42	42	36	54	66
Flour (sacks) .... per 2,240 lbs .	3 60	3 60	3 30	2 40 / 3 00	2 40	3 00	3 30	3 60	3 30	3 30	4 80	5 70
Bacon .... do ...	6 00	6 00	4 80	4 80	4 80	5 40	5 40	6 00	4 80	6 00	7 20	10 80
Lard .... do ...	4 80	5 40	4 20	4 20	3 00	4 20	4 80	4 80	4 80	4 80	6 00	9 60
Cheese .... do ...	7 20	7 20	6 00	6 00	6 00	8 40	9 60	10 80	8 40	7 20	9 60	12 00
Tallow .... do ...	4 20	3 48	3 60	3 30	3 00	3 60	3 60	4 80	4 20	4 20	6 00	8 40
Beef .... per tierce..	96	1 08	96	90	84	84	96	1 08	96	84	1 20	1 68
Pork .... per bbl..	66	78	66	60	66	66	66	84	84	66	90	1 20
Oil-cake .... per 2,240 lbs..	3 60	3 60	3 00	3 00	2 40	3 00	3 00	3 60	3 30	3 60	4 50	5 40
Hops .... per lb..	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	1	1
Tobacco .... per hhd..	4 80	4 80	3 60 / 4 80	4 20	4 80	4 80	4 80	4 80	4 80	4 80	6 00	7 20
Rosin .... per 280 lbs..	36	48	30	24	30	33	42	48	36	48	72	78

OCEAN STEAMSHIP COMPANIES—Continued.

ANCHOR LINE—NEW YORK TO GLASGOW—Continued.

Articles.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Lard, in small packages .... per 2,240 lbs..	$6 00	$7 20	$6 00	$6 00	$5 40	$7 20	$8 40	$7 20	$6 00	$7 20	$8 40	$10 80
Tobacco, in cases .... per 40 cu. ft..	4 80	5 40	4 80	4 80	4 20	4 80	4 80	4 80	4 80	4 80	4 80	5 40
Measurement per ton .... do ...	4 80	3 60	4 20	4 20	4 20	4 20	4 20	4 20	4 20	4 20	4 80	5 40
Primage .... per cent..	5	....	5	5	5	....	5	5	5	5	5	5

C.—INMAN LINE—NEW YORK TO LIVERPOOL.

Articles.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Wheat .... per bush..	$0 03	$0 08	$0 04	$0 04	$0 03	$0 05	$0 07	$0 11	$0 06	$0 08	$0 10	$0 14
Corn .... do ...	03	08	04	04	03	05	7	11	6	8	10	14
Flour .... per bbl..	30	48	36	24	24	36	36	60	42	48	60	72
Flour (sacks) .... per 2,240 lbs..	2 40	3 60	2 40	1 80	1 80	2 40	3 00	8 90	3 00	3 60	3 90	6 00
Bacon .... do....	3 60 / 4 80	6 00	3 60	3 00	2 40	4 20	4 20	7 20	4 80	6 00	6 00	9 60
Lard .... do....	3 60 / 4 80	6 00	3 60	3 00	2 40	4 20	4 20	7 20	4 80	6 00	6 00	9 60
Cheese .... do....	4 80	7 20	4 80	4 20	3 60	8 40	8 40	9 60	6 00	7 20	7 20	10 80
Tallow .... do....	3 60	5 40	3 60	3 00	2 40	3 60	4 20	6 60	4 80	5 40	6 00	9 00
Beef .... per tierce..	84	1 08	72	48	48	72	84	1 20	96	1 08	1 08	1 68
Pork .... per bbl..	60	84	48	30	36	54	60	84	72	84	84	1 20
Oil cake .... per 2,240 lbs..	2 40	3 00	1 80	1 20	1 80	2 40	3 00	3 60	2 70	3 30	3 60	5 40
Cotton .... per lb..	3/8	7/16	1/2	1/4	1/4	[illegible]	13/32	7/16	1/4	1/2	7/16	7/16
Hops .... do...	7/8	7/8	7/8	7/8	1/4	[illegible]	1	1	1	1	7/8	7/8
Tobacco .... per hhd..	6 60	7 20	6 00	6 00	5 40	6 00	6 00	6 60	5 40	7 20	7 20	7 20
Rosin .... per 280 lbs..	60	60	36	24	18	48	48	72	42	72	72	96
Lard, in small packages ... per 2,240 lbs..	6 00	7 20	4 80	4 20	3 60	7 20	8 40	8 40	6 00	7 20	7 20	10 80
Tobacco, in cases .... per 40 cu. ft..	4 80	5 40	4 80	4 80	3 60	4 80	5 40	6 00	4 80	4 80	6 00	6 00
Measurement per ton .... do....	4 20 / 6 00	4 80 / 6 00	3 60 / 6 00	3 60 / 6 00	4 80	4 80 / 6 00	4 80 / 6 00	6 00	4 80	4 80 / 6 00	4 80 / 6 00	6 00
Primage .... per cent..	5	5	5	5	5	5	5	5	5	5	5	5

D.—GENERAL TRANSATLANTIC COMPANY—NEW YORK TO HAVRE.

Articles.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Wheat .... per bush..	....	$0 10	$0 07	$0 06	....	$0 06	$0 07½ / 8	12 to 15	$0 10 / 12½	$0 08 / 9	$0 14	$0 12
Corn .... do....	....	11	08	07	....	07	7 / 8	12 to 16	9 / 11	9 / 10	13	14

Flour ....per bbl..	1 00	1 00	90	90	1 00	90	80	80	80	75	80	1 00
Flour (sacks) ....per 100 lbs..	30	25	22½	22½	22½	20	20	20 to 1 00	20	17½	25	27½
Bacon ....do....	30	....	22½	22½	22½	20	....	....	....	....	....	....
Lard ....do....	30	25	22½	22½	22½	20	20	22½ to 1 00	20 / 22½	17½	25	27½
Cheese ....do....	40	40	30	35	30	25	40	40	40	35	40	50
Tallow ....do....	30	25	22½	22½	22½	20	20	22½	20 / 22½	17½	25	27½
Beef ....per tierce..	1 25	1 20	1 00	1 00	1 25	1 25	1 00	1 25	1 25	1 00	1 25	1 25
Pork ....per bbl..	1 00	1 00	90	90	1 00	1 00	90	1 00	1 00	75	1 00	1 00
Oil cake ....per 100 lbs..	40	40	30	30	30	30	35	....	....	....	....	....
Cotton ....per lb..	7/16	7/16	15/32	15/32	3/8	3/8	3/8	3/8	3/8 / 7/16	11/32	7/16	7/16
Hops ....do....	3/4	3/4	1/2	3/4	3/4	3/4	1	1	1	1	1	1¼
Tobacco ....per hhd..	8 00	8 00	8 00	8 00	8 00	8 00	7 50	7 00 to 8 00	6 50 / 8 00	6 50	7 00 / 8 00	8 00
Rosin ....per 280 lbs..	....	....	....	....	....	....	90	....	....	....	....	....
Lard, in small packages ....per 100 lbs..	35	6 72	6 16	27½	27½	25	25	27½	25 / 50	22½	30	32½
Tobacco, in cases ....per 40 cu. ft..	8 00	8 00	8 00	8 00	8 00	8 00	7 00	7 00	7 00	6 00	8 00	8 00
Measurement per ton ....do....	8 00	8 00	8 00	8 00	7 00 / 8 00	7 00	7 00	8 00	7 00 / 8 00	6 50	6 00 / 8 00	7 00 / 8 00
Primage ....per cent..	5	5	5	5	5	5	5	5	5	5	5	5

E.—GUION LINE—NEW YORK TO LIVERPOOL.

Wheat ....per bush..	$0 03	$0 07½	$0 04	$0 02	$0 02	$0 04	$0 06½	$0 11	$0 05	$0 08	$0 10	$0 14
Corn ....do....	3	7½	3½	2	2	4	6½	10	5	8	9½	14
Flour ....per bbl..	....	48	24	24	24	48	48	60	42	....	48	....
Flour (sacks) ....per 2,240 lbs..	3 60	3 60	1 20	1 20	1 20	2 40	2 40	4 80	3 00	....	3 60	....
Bacon ....do....	3 60	6 00	3 60	3 00	2 40	3 60	4 20	6 00	4 80	4 80	6 00	8 40
Lard ....do....	3 60	6 00	3 60	3 00	2 40	4 80	4 80	6 60	4 80	4 80	6 00	9 60
Cheese ....do....	4 80	7 20	4 80	4 20	4 80	9 00	9 60	9 60	6 00	6 00	7 20	9 60
Tallow ....do....	3 60	6 00	3 00	2 40	1 80	3 60	4 80	6 60	4 20	4 80	6 00	8 40
Beef ....per tierce..	72	1 08	72	48	48	72	72	1 20	96	96	1 08	1 68
Pork ....per bbl..	48	84	48	36	36	48	54	84	72	72	84	1 20
Oil-cake ....per 2,240 lbs..	....	3 00	1 20	1 20	1 20	2 40	2 40	....	3 00	....	3 60	....
Cotton ....per lb..	7/16	7/16	1/4	1/4	1/4	5/16	3/8	3/8	1/4	7/16	7/16	7/16
Hops ....do....	7/8	7/8	3/8	7/8	3/8	1/2	1	3/8	7/8	7/8	7/8	3/8
Tobacco ....per hhd..	4 80	6 00	4 80	4 80	....	6 00	6 00	....	4 80	....	....	....
Rosin ....per 280 lbs..	....	72	21	12	....	....	....	....	....	....	....	....
Lard, in small packages ....per 2,240 lbs..	4 80	7 20	4 80	3 60	4 80	7 20	7 20	....	....	....	....	9 60
Tobacco, in cases ....per 40 cu. ft..	4 80	6 00	3 60	4 80	....	4 80	4 80	....	4 80	....	....	....
Measurement per ton ....40 cu. ft..	3 60 / 6 00	3 60 / 6 00	2 40 / 6 00	2 40 / 4 80	2 40 / 6 00	3 60 / 7 20	4 80	4 80 / 7 20	3 60 / 7 20	4 80	4 80	6 00 / 9 60
Primage ....per cent..	5	5	5	5	5	5	5	5	5	5	5	5

OCEAN STEAMSHIP COMPANIES—Continued.

F.—WHITE STAR LINE—NEW YORK TO LIVERPOOL.

Articles.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Wheat ... per bush..	$0 03	$0 08	$0 04	$0 02	$0 04	$0 04	$0 07	$0 11	$0 05	$0 08½	$0 09½	$0 13½
Corn ... do ..	3	8	4	2	4	4	7	11	5	8½	9½	13½
Flour ... per bbl .	36	60	36	24	24	48	60	60	42	60	72	84
Flour (sacks) ... per 2,240 lbs..	2 40	3 60	48	1 80	1 80	2 40	8 00	4 80	3 00	4 20	4 20	6 00
Bacon ... do....	4 80	6 00	3 60	3 00	2 40	4 20	4 50	6 90	4 80	6 00	6 00	9 60
Lard ... do....	4 80	6 00	3 60	3 00	2 40	4 20	4 50	6 00	4 80	6 00	6 00	9 60
Cheese ... do....	4 80	7 20	4 80	4 80	3 60	7 20	8 40	9 00	6 00	7 20	7 20	10 80
Tallow ... do....	4 80	6 00	3 60	2 40	1 80	4 20	4 20	6 00	4 20	6 00	6 00	9 60
Beef ... per tierce..	96	96	72	48	48	72	72	96	84	1 08	1 20	1 92
Pork ... per bbl..	60	72	48	36	36	48	60	72	60	78	84	1 32
Oil-cake ... per 2,240 lbs..	2 40	3 00	1 20	1 20	1 50	2 40	2 40	3 90	2 40	3 00	3 00	5 40
Cotton ... per lb..	3/8	7/16	1/2	1/2	3/16	5/16	3/8	13/32	1/2	7/16	[illegible]	7/16
Hops ... do....	7/8	1½	7/8	7/8	½	5/8	1¼	1	3/4	1	[illegible]	3/8
Tobacco ... per hhd..	6 00	7 20	4 80	4 80	4 80	4 80	6 00	6 00	4 80	7 20	7 20	9 60
Rosin ... per 280 lbs..	36	48	24	24	24	2 40	60	72	34	72	72	96
Lard, in small packages ... per 2,240 lbs..	4 80	7 20	4 80	4 80	4 80	7 20	7 20	7 20	4 80	7 20	8 40	10 80
Tobacco, in cases ... per 40 cu. ft..	4 80	4 80	3 60	4 80	4 80	3 60	3 60	4 20	5 40	4 80	4 80	4 80
Measurement per ton ... 40 cu. ft..	3 60 6 00	4 80 6 00	2 40 4 80	4 80	2 40 6 00	2 40 6 00	3 60 6 00	2 40 6 00	4 80	3 60 6 00	3 60 6 00	4 80 6 00
Primage ... per cent..	5	....	5	5	5	5	....	5	5	5	5	5

G.—NORTH GERMAN LLOYD STEAMSHIP COMPANY—NEW YORK TO BREMEN.

Articles.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Wheat ... per 100 lbs..	$0 20	$0 20 $0 22	$0 20	$0 15	$0 15	$0 12½	$0 12½	$0 18	$0 17	$0 20	$0 20	$0 22
Corn ... do....	20	20 22	20	15	15	12½	12½	18	17	20	20	22
Flour ... per bbl..	70	70	70	70	70	60	60	60	72	72	72	75
Flour (sacks) ... per 100 lbs..	25	25	25	24	22	22	20	24	24	22	24	25
Bacon ... do....	25	30	25	20	20	20	24	30	30	26	30	30
Lard ... do....	30	30	25	20	22	22	24	30	30	26	30	30
Cheese ... do....	40	00	40 60	40	48	48	36	40	40	40	40	40
Tallow ... do....	25	25	25	20	20	20	24	30	30	26	30	30
Beef ... per tierce..	1 40	1 50	1 40	1 40	1 40	1 40	1 40	1 50	1 50	1 40	1 50	1 80
Pork ...	1 00	1 00	1 00	1 00	75	75	75	1 00	1 00	90	1 00	1 00

1884—THE CROPS OF THE YEAR.

The year has been one of average fruitfulness. In freedom from adverse meteorological influences of winter and early spring, so injurious to winter crops, it may be placed among the best in its results upon grains and forage grasses. Final reports of condition of wheat since 1870 have not averaged higher except in 1877 and 1882, though it was the same in 1874, and less by only one point in 1879, when the census average was thirteen bushels per acre. The season was less favorable for corn, though the best since 1879. The average of condition in October was 93, the highest of five successive years, following a series of five years all above an average, ranging from 96 to 101. The result is almost exactly an average of the last ten or fifteen years, very nearly twenty-six bushels per acre.

The temperature of the season has made a somewhat eccentric record. In April the average of temperature of the whole country was lower than usual, except in the Pacific coast region and on the northern plateau. In May it was slightly higher on the Atlantic coast, and a trifle lower than usual in the interior basin from Lakes to Gulf. It was still below an average in June in the Middle and Southern States, and up to or above the average in New England and the Central West. The average was not attained in July on the Atlantic coast, or by three or four degrees in the West, but was slightly exceeded in the Gulf States. August made some improvement in the great corn-growing section, while remaining somewhat below an average, the cotton States coming up nearly to an average, with such absence of rainfall or irregularity in its distribution as to seriously affect the condition of corn and cotton and all late maturing crops. September made happy amends, with a temperature somewhat extraordinary over all crop areas except those of the Pacific coast. It was over twelve degrees above the average in the Eastern Gulf States, proving anything but a boon to that region. It was three or four degrees above an average in the West, and six degrees in the Middle States. In the more northern latitudes it proved an immense advantage in ripening the corn, saving it from another year's yield below an average. The unequal distribution of rainfall was a serious disadvantage in many districts. Drought was much more serious in the Ohio Valley than in the Missouri region, and Kansas and Nebraska have gained new laurels for abundance and reliability in crop production.

As has been hinted above, there was a deficiency of heat for early maturity of maize in the belt of principal production, and for the development of other summer crops, and in some districts an excess of moisture in the planting season. The study of the influence of temperature and rainfall on production is important in explanation of the causes producing obvious results, and the following tables, compiled from Signal Service records, are presented for the purpose of facilitating such investigation.

Average rainfall.

Districts.	April. Series of years.	April. 1884.	May. Series of years.	May. 1884.	June. Series of years.	June. 1884.	July. Series of years.	July. 1884.	August. Series of years.	August. 1884.	September. Series of years.	September. 1884.
	In.	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
New England	3.48	4.82	3.61	4.39	3.91	3.29	4.13	5.74	3.88	5.39	3.59	[illegible]
Middle Atlantic States	3.58	2.30	2.77	2.31	3.64	3.42	4.10	5.44	4.80	3.86	4.24	[illegible]
South Atlantic States	4.76	3.69	3.42	2.83	4.84	6.18	5.77	6.73	6.38	5.68	6.02	[illegible]
Florida Peninsula	2.60	2.46	3.63	2.55	5.14	6.04	6.18	4.80	7.47	5.49	6.43	[illegible]
Eastern Gulf States	5.90	5.29	4.83	5.14	4.44	8.11	4.82	4.80	6.01	2.00	4.47	[illegible]
Western Gulf States	4.62	5.65	5.03	9.40	3.81	4.70	4.00	2.71	3.74	1.96	4.24	[illegible]
Rio Grande Valley	2.74	0.75	2.68	5.50	2.21	1.38	2.25	0.11	5.63	0.44	3.76	[illegible]
Tennessee	5.83	5.62	3.84	3.62	4.22	7.09	3.92	4.71	3.89	2.85	3.38	[illegible]
Ohio Valley	3.50	2.62	3.60	4.66	4.62	2.95	4.56	4.21	3.40	2.28	2.54	[illegible]
Lower Lake Region	2.22	1.31	3.10	3.14	3.52	2.24	3.55	3.93	2.83	2.24	2.96	[illegible]
Upper Lake Region	2.18	2.63	3.60	3.00	4.12	2.31	3.31	2.90	2.85	3.09	3.73	[illegible]
Extreme Northwest	1.87	1.83	3.35	2.14	4.31	2.04	3.02	3.55	2.83	5.03	2.06	[illegible]
Upper Mississippi Valley	3.01	2.58	4.62	3.46	5.82	4.00	4.06	4.51	2.39	2.09	3.83	[illegible]
Missouri Valley	3.00	4.17	4.46	2.59	5.42	3.56	4.25	6.24	2.74	2.25	2.56	[illegible]
Northern Slope	1.80	1.20	2.90	1.80	2.42	2.68	1.46	3.24	1.37	1.73	1.29	[illegible]
Middle Slope	1.23	1.82	4.28	5.13	2.03	5.33	2.53	2.46	2.22	3.29	1.44	[illegible]
Southern Slope	0.76	2.73	2.01	5.41	2.49	2057	3.60	0.87	3.68	2.96	4.02	[illegible]
Southern Plateau	0.44	0.96	0.29	0.60	0.34	0.61	2.42	0.34	2.56	2.35	1.01	[illegible]
Northern Plateau	1.95	1.47	1.38	0.70	0.79	3.42	0.81	0.82	0.31	0.19	0.82	[illegible]
North Pacific Coast Region	3.08	3.55	2.87	1.22	1.14	2.17	0.69	0.82	0.82	0.64	1.84	[illegible]
Middle Pacific Coast Region	2.80	4.99	0.99	0.16	0.15	1.66	0.01	0.00	0.02	0.01	6.31	[illegible]
South Pacific Coast Region	1.04	2.16	0.29	1.00	0.03	0.57	0.08	0.01	0.16	0.11	0.05	[illegible]
Mount Washington, N. H.	4.36	3.29	4.36	9.54	9.60	8.08	9.82	23.90	7.54	8.63	9.00	[illegible]
Pike's Peak, Colo	3.61	0.43	3.61	2.90	1.92	0.94	4.94	0.41	4.55	0.25	2.08	[illegible]
Salt Lake City, Utah	2.40	2.89	2.40	1.78	0.71	0.33	0.62	0.27	0.86	0.73	0.74	[illegible]

Average temperature.

Districts.	April. Series of years.	April. 1884.	May. Series of years.	May. 1884.	June. Series of years.	June. 1884.	July. Series of years.	July. 1884.	August. Series of years.	August. 1884.	September. Series of years.	September. 1884.
	°	°	°	°	°	°	°	°	°	°	°	°
New England	43.3	44.2	54.5	53.6	63.6	64.8	69.3	66.3	67.9	67.6	61.7	[illegible]
Middle Atlantic States	49.8	49.5	61.1	61.9	70.6	69.9	75.5	72.9	73.6	73.2	64.7	[illegible]
South Atlantic States	61.3	59.9	69.7	71.6	77.3	73.5	80.6	79.7	78.7	77.2	74.1	[illegible]
Florida Peninsula	72.4	71.3	76.9	78.1	81.9	78.9	83.2	83.5	82.4	81.6	80.1	[illegible]
Eastern Gulf States	65.3	63.3	72.6	73.0	79.3	75.6	81.2	80.6	79.4	78.3	74.7	[illegible]
Western Gulf States	66.2	63.6	73.6	72.2	80.2	78.3	82.5	83.7	81.5	80.2	75.8	[illegible]
Rio Grande Valley	76.2	73.4	80.6	78.4	84.6	82.1	85.3	85.6	82.7	82.2	[illegible]	[illegible]
Tennessee	59.2	57.6	69.1	68.5	76.2	72.4	79.3	77.9	77.0	75.2	[illegible]	[illegible]
Ohio Valley	53.7	51.5	65.3	63.7	73.3	73.5	77.5	75.0	74.9	73.1	67.2	[illegible]
Lower Lake Region	43.2	42.2	56.5	55.3	65.5	67.3	71.0	66.8	69.7	67.9	62.2	[illegible]
Upper Lake Region	39.5	38.9	51.7	51.2	61.5	62.8	67.7	63.6	66.9	64.4	58.5	[illegible]
Extreme Northwest	37.9	37.6	53.0	53.5	62.0	66.4	67.8	63.1	66.4	64.4	54.5	[illegible]
Upper Mississippi Valley	52.9	49.8	62.0	61.8	71.0	70.9	75.8	73.0	74.1	70.9	64.2	[illegible]
Missouri Valley	47.9	46.1	61.4	60.1	70.6	72.0	74.3	71.8	73.5	69.5	[illegible]	[illegible]
Northern Slope	42.0	40.4	52.7	53.5	62.3	64.8	68.0	65.9	67.6	65.3	[illegible]	[illegible]
Middle Slope	52.2	48.2	61.4	58.4	70.5	70.1	74.7	75.9	73.2	70.4	[illegible]	[illegible]
Southern Slope	63.7	58.3	71.9	66.8	78.5	75.7	80.0	83.7	76.8	78.1	[illegible]	[illegible]
Southern Plateau	58.8	55.4	68.5	65.5	77.7	73.9	81.8	82.8	79.2	78.5	73.0	[illegible]
Northern Plateau	48.7	51.5	55.8	61.0	64.8	66.2	70.8	67.4	68.9	71.8	50.2	[illegible]
North Pacific Coast Region	49.9	52.2	54.8	58.2	60.8	60.7	64.8	62.7	63.4	66.8	58.3	[illegible]
Middle Pacific Coast Region	57.1	56.2	62.0	63.4	68.7	64.8	71.4	69.9	70.1	70.9	61.3	[illegible]
South Pacific Coast Region	61.6	60.7	66.9	66.1	71.9	70.6	75.9	76.4	75.2	76.6	72.9	[illegible]
Mount Washington, N. H.	20.6	25.4	33.5	32.0	43.7	49.0	47.9	44.6	47.2	47.7	40.7	[illegible]
Pike's Peak, Colo	13.0	8.5	22.1	20.4	33.0	30.4	40.3	39.8	39.0	35.6	31.2	[illegible]
Salt Lake City, Utah	49.3	48.0	57.9	57.7	68.3	68.7	76.3	73.4	75.3	72.6	64.9	[illegible]

The more important agricultural districts of the South and West are above or below an average, as follows, in temperature and rainfall:

Months.	South Atlantic.		Western Gulf.		Ohio Valley.		Missouri Valley.		Extreme Northwest.	
	Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.
	°	°	°	°	°	°	°	°	°	°
April	−1.4	−1.07	−2.6	+1.03	−2.2	−3.59	−1.8	+1.17	− .3	− .04
May	+1.9	− .59	−1.4	+4.37	−1.6	+1.06	−1.3	−1.87	+ .5	−1.21
June	−3.8	+1.34	−1.9	+ .89	+ .2	+1.67	+1.4	−1.86	+4.4	−2.27
July	− .9	+ .96	−1.2	−1.29	−2.5	− .35	−2.5	+1.99	−4.7	+ .53
August	−1.5	− .70	−1.3	−1.78	−1.8	−1.21	−4.0	+ .51	−2.0	+2.20
September	+1.6	−1.63	+3.6	+ .87	+5.1	+1.21	+3.6	− .06	+ .9	+ .64
October	+3.0	−3.17	+1.8	−.04	+3.0	−1.44	+4.3	+.54	+2.5	+.21

CORN.

The season for planting and early growth was generally favorable, except that some areas had too much rain. In July the stand appeared unusually healthy in color, and was growing rapidly. High condition was reported, the average being 96. This was higher than in any year since 1874, with two exceptions, 1879 and 1880. The same average was maintained in August, and high hopes began to be entertained for the harvest. Improvement was reported in Iowa, Missouri, Kansas, Nebraska, and Georgia, and a slight decline in Ohio, Indiana, Illinois, and in some of the Southern States, from the prevalence of drought, in which the Ohio Valley and Texas suffered most noticeably. The average of condition in September was 94, a figure which assured a medium crop, should severe frosts in September be averted. In October a well ripened crop, of medium rate of yield, was reported. The high temperature of September had saved it from disaster in the higher latitudes.

The result is a crop, according to our full estimates, of 1,795 millions of bushels, the largest ever grown in quantity, though by no means the largest in rate of yield. It reaches an average yield of 25.6 bushels per acre, which has not been exceeded since 1880. The farm value of this crop is $640,135,859—35.8 cents per bushel, against 42 cents for the crop of 1883. It is, therefore, valued less, by eighteen millions of dollars, than the previous crop. The acreage is estimated at 69,682,780 acres. The estimates by States, are:

CORN.

States and Territories.	Acres.	Bushels.	Value.
Maine	30,610	1,062,000	$796,500
New Hampshire	38,774	1,286,000	967,360
Vermont	60,282	1,998,700	1,299,155
Massachusetts	57,097	1,941,300	1,397,736
Rhode Island	12,818	390,000	304,200
Connecticut	57,000	1,767,790	1,149,005
New York	753,810	22,674,300	13,640,580
New Jersey	343,500	10,992,032	5,935,697
Pennsylvania	1,403,000	43,466,000	22,602,320
Delaware	214,450	3,975,000	1,709,250
Maryland	698,400	15,237,000	7,313,760
Virginia	1,938,391	29,480,000	16,508,800
North Carolina	2,519,927	31,499,000	18,899,400
South Carolina	1,444,020	13,320,000	9,057,600
Georgia	2,857,700	30,925,000	21,647,500

CORN—Continued.

States and Territories.	Acres.	Bushels.	Value.
Florida	403,913	3,837,000	$3,0[illegible]
Alabama	2,322,885	30,197,000	18,[illegible]
Mississippi	1,889,600	25,510,000	15,[illegible]
Louisiana	865,450	11,007,000	7,[illegible]
Texas	8,752,700	60,290,000	37,[illegible]
Arkansas	1,757,710	32,465,000	17,[illegible]
Tennessee	3,245,682	65,723,000	29,[illegible]
West Virginia	594,115	11,000,000	6,[illegible]
Kentucky	3,258,410	71,880,000	30,9[illegible]
Ohio	2,846,604	83,303,000	35,[illegible]
Michigan	929,388	26,022,000	10,[illegible]
Indiana	3,612,312	104,757,000	35,[illegible]
Illinois	8,151,463	244,544,000	75,[illegible]
Wisconsin	1,086,685	26,200,000	8,[illegible]
Minnesota	705,310	23,680,000	7,[illegible]
Iowa	7,329,652	252,600,000	58,[illegible]
Missouri	5,095,931	197,850,000	51,4[illegible]
Kansas	4,565,000	168,500,000	37,[illegible]
Nebraska	3,235,298	122,100,000	21,[illegible]
California	160,000	8,800,000	2,[illegible]
Oregon	5,890	164,000	[illegible]
Nevada	830	21,000	[illegible]
Colorado	25,300	710,000	[illegible]
Arizona	2,850	60,300	[illegible]
Dakota	465,000	13,950,000	4,1[illegible]
Idaho	1,820	36,400	[illegible]
Montana	830	20,700	[illegible]
New Mexico	47,200	950,000	[illegible]
Utah	13,473	202,000	[illegible]
Washington	3,210	105,000	[illegible]
Total	69,683,780	1,705,728,432	[illegible]

WHEAT.

The area of the previous crop was greatly reduced by winter-kill and substitution of other crops. The present breadth is therefore g by nearly 3,000,000 acres. The area harvested is estimated at 39,4[illegible] acres, which exceeds that in wheat in any previous year, in [illegible] country, as well as any other in the world. The report in April sho[illegible] that in Michigan, New York, and Connecticut wheat was still pro[illegible] by a covering of snow. Little mention of killing by winter al[illegible] tions of temperature was made by correspondents. The fine app[illegible] of drilled grain was generally attested. The early-sown ar[illegible] superior to late sown in the Middle States. Seeding in Mary[illegible] generally late, and only the early sown had a good growth and su[illegible] root development. The average date of sowing in Virginia was [illegible] days later than usual, yet a fair growth was made in the autumn, especially in the grain districts of the Shenandoah Valley and am[illegible] the best farms of other sections. A fair start, producing plants menium vigor and promise, was made in the Carolinas and Geor[illegible] and similar conditions produced average growth in Alabama and [illegible]sissippi. In Tennessee a vigorous root growth was obtained in [illegible] and tillering commenced before winter set in, in the earliest [illegible] advanced fields. The late seeding was not so successful. The [illegible] too dry at seeding time at many points in Texas. In some c[illegible] late sowings had the most favorable conditions, avoiding the drought that sapped the vitality of some early growths, causing either their entire destruction or great injury. The fields first seeded in West Virginia were the most promising. The later breadths were slow in starting, from drought and insufficient soil preparation, and not well

fortified against the vicissitudes of winter. There was much mention of dry weather and slow growth in Kentucky, yet the development was very satisfactory on the best wheat soils. Drought had an adverse influence in the drier soils of Ohio, retarding development, so that the plants were generally small, yet with an appearance of health. There was great diversity of appearance on different soils. The lands improved by systematic drainage were uniformly promising of good re- lts. The autumn was dry in Michigan, and the plants small when winter set in. The Indiana reports were not generally favorable as to early-sown wheat. The medium seeding more frequently gave better results. The weather was too dry for an early start. Similar conditions prevailed in Illinois. Much of the crop had made but little growth when winter set in, and winter-killing of late wheat was feared. The seeding was unusually late. In Missouri the early growth was delayed by drought, but the later conditions were more favorable, and a fair growth was reported.

The early sown is not always the most vigorous. Conditions were quite favorable for vigorous growth in Kansas. Rains were ample, and the ground was prepared better than in former years. On the Pacific coast the seeding was delayed by dry weather, but an increased area and fine growth was ultimately secured by seasonable and abundant rains.

In May, condition was still reported high. In the more northern of the Atlantic coast States rain in excess, with low temperature, retarded growth, so that the plant was small, though healthy. In cold and wet soils of Pennsylvania and New Jersey growth was slow, while the mellow soils showed a stand rich in promise. The reports from Maryland indicated high condition, except on cold clay soils. The crop was already heading in North Carolina, and promising ripeness for harvest by the 10th of May. Prospects were generally favorable throughout the South, especially in Texas and Tennessee. Kentucky fields were in superior condition. North of the Ohio, condition was less favorable. In Ohio, Indiana, and Michigan condition stood 15 per cent. below the standard. There had been some winter injury in Illinois, and low lands had been flooded in the spring. The May reports from the Pacific coast were very favorable.

The condition of spring wheat in June was very high, averaging 101. Winter wheat at the same time was reported at 93. The cool, moist weather had been generally favorable to healthy growth and to tillering. Rust began to be observed in Virginia, Kentucky, and Indiana, and to some extent elsewhere. The early sown, as a rule, was most promising, and the drilled areas were decidedly superior to those sown broadcast. In this month the harvest was completed in the northern belt of the Southern States.

In July the condition of spring wheat was returned at 100, and of winter wheat at 94.

The result of the harvest as estimated for final record is by States as follows:

WHEAT.

States and Territories.	Acres.	Bushels.	Value.
Maine	41,965	629,400	$786,750
New Hampshire	11,615	170,700	204,840
Vermont	21,789	364,500	382,725
Massachusetts	1,070	19,000	21,280
Rhode Island	....	....	....
Connecticut	2,193	36,200	36,200

WHEAT—Continued.

States and Territories.	Acres.	Bushels.	Value
New York	772, 323	12, 720, 000	$10,41
New Jersey	155, 540	2, 022, 000	1,52
Pennsylvania	1, 533, 660	20, 820, 000	17,96
Delaware	91, 790	1, 007, 000	85
Maryland	644, 980	8, 290, 000	6,65
Virginia	930, 200	7, 455, 000	5,84
North Carolina	767, 290	4, 650, 000	4,73
South Carolina	231, 610	1, 410, 000	1,46
Georgia	487, 500	3, 120, 000	3,26
Florida	....	....	....
Alabama	278, 450	1, 675, 000	1,65
Mississippi	48, 060	257, 600	25
Louisiana	....	....	....
Texas	556, 600	5, 560, 600	4,86
Arkansas	248, 450	1, 885, 000	1,73
Tennessee	1, 336, 230	9, 320, 000	6,99
West Virginia	316, 125	3, 318, 000	2,65
Kentucky	1, 272, 000	13, 425, 000	9,93
Ohio	2, 691, 936	41, 186, 000	30,89
Michigan	1, 804, 465	29, 772, 000	22,03
Indiana	2, 708, 016	33, 745, 000	22,60
Illinois	2, 790, 900	32, 374, 000	20,395
Wisconsin	1, 434, 510	20, 083, 000	12,04
Minnesota	2, 753, 816	41, 307, 000	20,65
Iowa	2, 605, 771	31, 270, 000	17,196
Missouri	2, 334, 766	27, 500, 000	17,050
Kansas	2, 120, 500	34, 990, 000	15,745
Nebraska	1, 950, 280	28, 325, 000	11, 896
California	3, 360, 000	44, 320, 000	31,910
Oregon	858, 024	15, 462, 000	7,421
Nevada	5, 515	104, 000	104
Colorado	117, 420	2, 348, 000	1,314
Arizona	20, 550	275, 000	206
Dakota	1, 540, 200	22, 330, 000	10,271
Idaho	50, 400	1, 120, 000	806
Montana	76, 240	1, 372, 000	960
New Mexico	68, 450	930, 000	837
Utah	93, 100	1, 675, 000	1,373
Washington	326, 366	4, 118, 000	2,470
Wyoming	2, 120	33, 900	....
Total	39, 475 885	512, 763, 900	330, 861

OATS.

The crop of oats of this year, like that of corn, is the larg[...]gate ever grown in this country. The area is larger by a million [...] The estimated product is 583,628,000, against 571,302,400 in 1883. [...] yield per acre, as estimated, is 27.4 bushels; in 1883, 28.1 bushels. [...] average of condition was not quite so high as in 1883. The price p[...] bushel is 27.7 cents, a reduction of 5.3 cents from the price of the p[...]vious crop, and the lowest price ever reported, except the average [...] 24.6 cents in 1878, when the yield was given at 31.4 bushels per ac[...] and the aggregate the largest ever made up to that date. The pr[...] was then influenced by the downward tendency of corn during a se[...] of good corn years. The estimates by States are as follows:

States and Territories.	Acres.	Bushels.	Valu
Maine	83, 733	2, 428, 000	$1,0
New Hampshire	30, 588	993, 000	4
Vermont	103, 530	8, 625, 000	1,4
Massachusetts	23, 560	717, 000	3
Rhode Island	5, 882	161, 000	
Connecticut	37, 512	1, 112, 000	
New York	1, 371, 530	41, 145, 000	14
New Jersey	129, 564	2, 735, 000	1,
Pennsylvania	1, 253, 868	35, 027, 000	12,2
Delaware	20, 580	482, 000	1

OATS—Continued.

States and Territories.	Acres.	Bushels.	Value.
Maryland	110, 000	1, 980, 000	$693, 000
Virginia	621, 230	6, 418, 000	2, 695, 560
North Carolina	617, 646	4, 632, 000	2, 126, 120
South Carolina	394, 250	3, 545, 000	1, 772, 500
Georgia	702, 614	6, 270, 000	3, 573, 900
Florida	52, 560	494, 000	296, 400
Alabama	405, 830	5, 015, 000	2, 758, 250
Mississippi	348, 040	3, 048, 000	1, 737, 360
Louisiana	35, 119	404, 000	234, 320
Texas	478, 510	10, 527, 000	4, 421, 340
Arkansas	228, 440	3, 542, 000	1, 593, 900
Tennessee	568, 895	7, 680, 000	3, 225, 600
West Virginia	130, 225	2, 212, 000	862, 680
Kentucky	427, 430	7, 865, 000	2, 752, 750
Ohio	836, 400	23, 419, 000	6, 791, 510
Michigan	597, 864	19, 990, 000	5, 797, 100
Indiana	724, 736	21, 742, 000	5, 870, 340
Illinois	2, 990, 983	98, 153, 000	22, 575, 190
Wisconsin	1, 371, 384	45, 940, 000	11, 025, 600
Minnesota	1, 025, 136	36, 100, 000	7, 220, 000
Iowa	2, 145, 959	78, 650, 000	15, 730, 000
Missouri	1, 152, 590	30, 774, 000	7, 693, 500
Kansas	783, 413	27, 419, 000	6, 032, 180
Nebraska	648, 193	21, 844, 000	4, 150, 360
California	79, 600	2, 149, 000	816, 620
Oregon	195, 350	5, 470, 000	1, 641; 000
Nevada	7, 858	251, 000	145, 580
Colorado	43, 312	1, 516, 000	606, 400
Arizona			
Dakota	312, 000	11, 812, 000	2, 716, 760
Idaho	33, 750	1, 012, 000	435, 160
Montana	52, 000	1, 740, 000	609, 000
New Mexico	12, 583	252, 000	105, 840
Utah	26, 120	650, 000	227, 500
Washington	75, 100	2, 623, 000	918, 050
Wyoming	2, 500	75, 000	30, 000
Total	21, 300, 917	583, 628, 000	161, 528, 470

COTTON.

The following is the telegraphic synopsis of the December report:

The December report of the Department of Agriculture indicates a smaller yield than the returns of condition in October. The October average was 74, against 68 in 1883, 88 in the great harvest of 1882, and 66 in the disastrous season of 1881. The returns of condition in October and of product in December have been unusually divergent this year. The first indicated a larger crop than last year; the latter a product slightly less, or about 98 per cent. The comparative decline is i the States west of Alabama. The comparison with last year is as follows: North Carolina, 100; South Carolina, 107; Georgia, 101; Florida, 103; Alabama, 105; Mississippi, 94; Louisiana, 98; Texas, 89; Arkansas, 99; Tennessee, 101.

Applying these percentages to our figures for the crop of 1883, they indicate a product of 398,000 bales in North Carolina, 502,000 in South Carolina, 760,000 in Georgia, 60,000 in Florida, 661,000 in Alabama, 847,000 in Mississippi, 480,000 in Louisiana, 995,000 in Texas, 513,000 in Arkansas, and 314,000 in Tennessee. The remaining territory will probably give about 50,000 bales. This makes an aggregate of 5,580,000 bales.

These figures are provisional and may be slightly modified by future returns. It is possible that the general disappointment at the outcome of the middle and top crop have made the December returns unusu-

ally conservative, but it is certain that the rate of yield will be much below the average.

It is the experience of the Department that returns of final product are much too low, not by a uniform percentage, for the local estimates are more depressed in a year of partial failure than in one of good yield. The inevitable tendency of declining production is to depress the spirits and bias the judgment of the reporter. The peculiar features of the present crop history cause a wide discrepancy between condition in tember and October, and comparative product reported later. In al- lowing for this depression, in such a year as this, there is a p that figures may remain too low. The October returns of condi notwithstanding the difference in subsequent dates of killing frost, have in former years pointed quite closely to the ultimate result. In the census year the October average was 81, and the crop 5,755,359 bales.

The average of condition in October, and the commercial movem for four crops since 1879, bear relation as follows:

Years.	Average.	Movement.
		Bales.
1880	84	6,605,750
1881	66	5,456,048
1882	88	6,949,756
1883	68	5,713,200

The October average of 1884 was 74, but the failure of subsequent fruitage was very marked, making it evident that these October indications would not this year point so nearly to the ultimate product. It would still seem possible, however, that the crop may equal that of last year, though the December returns do not warrant such a conclusion, and they are given above, with such corrections only as former experience has shown to be necessary. While it is absurd to report local estimates, or census returns, even, without revision and correction, it has been the practice of this Bureau to give from month to month a fair interpretation of the returns, and not an individual estimate based on them. The interested public can thus read the history of the crop development and disasters, and reach a conclusion in accord with it; and it is very certain that individual conclusions will ever be modified by personal interest whatever the official figures. The quality of cotton is unusually good. There was little damage from rain, and a small proportion of stained fiber. Some correspondents declared that there was no stained cotton. Similar reports came from Georgia and Alabama, and substantially from those farther west.

The falling off of the top crop—the blighting of the later bolls, and their failure to mature—is almost unprecedented, according to the returns of correspondents.

FARM PRICES OF THE CROP OF 1884.

The records of the prices of farm products are made in December. They are the basis of value of the crops of the year. The tendency to lower rates is observed everywhere as to most crops, not only from abundance of production, but in sympathy with the general depression in values of all commodities.

CORN.

The average price of corn is 36¼ cents, which is one cent lower than the average for 1879, where the supply in proportion to population was quite as large. It has been lower but twice in ten years, in 1877 and 1878, after two previous years of abundance. It is highest in Florida, 80 cents per bushel, and the lowest price is 18 cents in Nebraska; Kansas, 22; Iowa, 23; Missouri, 26; Illinois, 31; Minnesota, 33; Indiana and Wisconsin, 34; Michigan, 40; Ohio, 41; Kentucky, 43. It is 52 in Pennsylvania, 54 in New Jersey, and 60 in New York. The range of values in the South Atlantic States is from 43 in Delaware to 68 in South Carolina, and 80 in Florida, increasing in the order of movement, except that Georgia reports 70 cents. In the more western States, it is 45 in Tennessee, 54 in Arkansas, 61 in Alabama, 62 in Mississippi and Texas, and 67 in Louisiana.

The differences in value of corn in counties of the same State are very wide, owing to relative abundance or scarcity, transportation facilities, or other causes. Nebraska returns 18 cents per bushel as the State average for corn, while in Otoe County the value is 23 cents, and in Boone 12 cents. In several counties in Kansas corn is worth but 15 cents; in several others farther west, as Ford and Ness, 40 cents, where it is scarce and in demand, while the State average is 22.

In several of the eastern counties of Iowa the price is returned at 30 cents, in Des Moines 35 cents; the range is from 15 cents in Monona to 40 in Delaware. The range of prices in Minnesota is from 20 to 50 cents. A greater difference is seen in Missouri, between 12 cents in Holt County and 50 in Saint François, though 20 and 25 are more frequent figures for other counties.

Farther west prices are higher, with similar margins of local difference. Very few counties in Ohio report lower than 30 cents, and a large number between 30 and 40, while 50 is given as the average for Adams, Highland, Holmes, Hocking, Harrison, Jackson, Knox, Muskingum, Noble, and Perry. In Geauga, Guernsey, and Belmont the price is 60, and in Jefferson 65 cents. Among the highest returns from New York is 60 cents for Schenectady and Westchester, the lowest 40 cents from Niagara, and 50 cents Chautauqua, Genesee, Jefferson, and Wyoming. A similar range is observed in Pennsylvania, Lebanon reporting 40 and Lancaster 50 cents. Higher prices prevail in New England, from 65 cents to $1 (in Aroostook) in Maine; 65 to $1 in New Hampshire; 62 to 75 in Vermont; 60 in Franklin to 85 in Dukes, Massachusetts; 69 in Kent to $1 in Newport, Rhode Island, and from 60 in New Haven to 75 in New London, Connecticut.

In the South still wider differences are apparent. The range is from 40 cents to 80 in Virginia, and the same in North Carolina. In Georgia from 50 cents to $1, though in most counties from 60 to 80 cents. It is gratifying to observe that very few counties in any of the cotton States report higher than 75 cents.

WHEAT.

The average farm price of wheat is 65 cents per bushel, against 91 cents last December. The December price in thirteen years has previously been below $1 per bushel but five times—in 1874, 1878, 1880, 1882, and 1883. The average in Nebraska is 42 cents, 45 in Kansas, 46 in Dakota, 50 in Minnesota, 55 in Iowa, 62 in Missouri, 63 in Illinois, 67 in Indiana, 74 in Michigan, and 75 in Ohio. The average home-grown

wheat in New England exceeds $1. In New York it is 85 cents, in Pennsylvania 86. It is 80 cents in Virginia, and 83 in Maryland.

The price of wheat is lower than it has ever been reported by this Department. It is said to be lower in Great Britain than at any other period of the present century. It is a result that is perfectly natural, and that has been predicted repeatedly in these reports. A series of crop failures altogether unprecedented in Europe, stimulating production all over the world, could have no other outcome. These low prices, however, will soon reduce the area and relieve overproduction.

In the distant wheat-fields the hardship of low prices is most severe. Clay County, in Dakota, returns the average price at 38 cents per bushel; Hamlin, 39; McCook, 40; Clark, 41; Hand, 42; Stutsman, 43; Grant, 44; Lincoln, 45; Hutchinson, 48; Davison, 50. The ave of 46 in Dakota is not the lowest; Kansas reports 45, the range being n 25 cents in Ellis to $1 in Ford, several counties reporting between and 40 cents. In Buffalo and Furnas, Nebraska, the price is 30 cents; in Otoe, 60; in Pawnee, 65. The range in Iowa is from 37 to 75. The lowest average in New York is 70 cents; the highest, $1.10. In some counties of Southern States wheat is valued as low as 50 cents, and in others, where it is scarce, at $1 or more. In the wheat belt of Texas the price is 50 to 60 cents, rising to a dollar, and in some cases higher in the cotton counties.

OATS.

The average value of oats is 28 cents, against 33 cents in 1883 and 37.5 in 1882. The present value is the lowest ever reported by the Department. The lowest State average is 19 cents, in Nebraska; the highest is 60, in Florida; Iowa and Minnesota, 20 cents; Kansas, 22; Illinois, 23; Indiana, 27; and Ohio, 29. The range is from 42 to 60 in the South.

POTATOES.

The average farm price of the entire crop of potatoes is 40 cents per bushel. The lowest price is 25 cents, in Michigan. The average in New York is 39 cents; 42 in Ohio, 35 in Indiana, 34 in Illinois, 28 in Iowa, 29 in Nebraska, 48 in Kansas. The average price is 2 cents lower than last year, though the crop is not so large.

COTTON.

The plantation price of cotton, as reported, ranges from 9 to 9¼ cents per pound. It is 9 cents in Tennessee, Arkansas, and Texas, 9.1 cents in Louisiana, 9.2 cents in Georgia, 9.3 cents in the Carolinas and Virginia.

The occurrence of two crops in succession scarcely equal to the requirements of manufacture has caused a slight increase in prices, and may produce a greater advance hereafter.

CORN AND WHEAT IN FORMER RECORDS.

The lowest State average price for corn in returns of fifteen years was 16 cents in Nebraska and Iowa in 1878. It has not been lower than at the present time, in any other year, in either of the States. The average for Missouri in 1879 was 23 cents, 1 cent more than the present value. In 1878 the Kansas average was 19, 3 cents lower than in 1884.

Wheat is lowest this year in Nebraska, 42 cents, which is the lowest average recorded in these reports. It was 49 cents in 1878. In the same year the Iowa average was 50 cents; that of Kansas 59, and of Missouri 67. These are the next lowest figures reported.

The following is a comparison of prices for fifteen years in these States:

Years.	Iowa.		Missouri.		Kansas.		Nebraska.	
	Corn.	Wheat.	Corn.	Wheat.	Corn.	Wheat.	Corn.	Wheat.
1870	$0 34	$0 78	$0 44	$0 91	$0 58	$0 86	$0 36	$0 64
1871	23	96	31	1 16	29	1 13	25	90
1872	18	85	32	1 41	22	1 42	18	78
1873	31	79	38	1 13	31	1 00	28	75
1874	43	65	74	83	91	84	23	60
1875	27	71	28	95	23	87	20	64
1876	25	90	28	89	24	86	27	72
1877	25	87	27	1 00	21	82	18	83
1878	16	50	26	67	19	59	16	49
1879	24	92	25	1 01	27	89	21	84
1880	26	82	36	89	29	70	25	73
1881	44	1 06	65	1 19	58	1 05	39	97
1882	38	70	39	85	37	67	33	67
1883	32	80	35	88	26	78	24	70
1884	23	55	26	62	23	45	18	42

CONCLUSION.

The foregoing material is a small part of the statistical matter prepared in the Bureau of Statistics of the Department of Agriculture. The statistical reports published monthly in 1884 comprised 603 printed pages. Statements made and investigations undertaken for other Departments of the Government, for representatives of foreign governments, members of Congress, boards of agriculture, boards of trade, writers for the press, and others, constitute a large portion of its work. Any effort tending to advance the public good and enlarge the efficiency of human labor, if legitimately coming within its official sphere, has been cheerfully and conscientiously made.

J. R. DODGE,
Statistician.

Hon. GEORGE B. LORING,
Commissioner.

CULTIVATION OF ALFALFA.*

In a country so widespread and diversified as the United States, it is not to be wondered at that a crop that is valued in some localities is unknown in others.

But it is somewhat surprising that, in many of the Southern States, where the want of forage is so much felt, that the culture of a plant so admirably adapted for their soil and climate has so long been negle l. In a visit to Florida, in February, 1883, I was impressed, as every No ern man must be, with the utter dearth of forage plants, and, as a (sequence, the hungry and meager starved-looking cattle. To my quiries everywhere the same reply was given, that no good g clover could be found to stand the heat and drought of their long mers. Fortunately, in alluding to the subject, while in the com] y of Mr. R. Bronson, of Saint Augustine, Fla., he promptly showed a p tical solution of the difficulty by taking me to a patch of alfalfa, al twenty-five feet by one hundred, or only about the one-sixteenth an acre. From that little patch Mr. B. assured me that he had i a cow during the summer months, getting as fine milk and butter as ever he got North; and further said that twice that area, or one-eighth part of an acre, would be ample to supply a cow with food during the entire season. The land used by Mr. Bronson for his experiment with alfalfa was identical with the thousands of acres in his immediate vicinity, which was given over to the blue palmetto and scrubby pines, through which the goat-like cattle browse out a miserable existence. Mr. Bronson, though only an amateur, is a careful observer, and an enthusiastic student in everything that relates to agriculture. In the culture of alfalfa for Florida and other Southern latitudes he advises that the crop be sown early in the fall; early enough to attain a height of 4 or 5 inches before growth is arrested by cold weather—in Florida say from 1st to 15th of October.

The soil best suited for the growth of alfalfa is that which is deep and sandy; hence the soil of Florida and many other portions of the cotton belt is eminently fitted. The plant makes a tap-root with few laterals, and its roots are often found at a depth of 6 to 8 feet, thus drawing food from depths entirely beyond the action of drought or heat. When alfalfa is to be grown on a large scale, to get at the best results the ground chosen should be high and level, or, if not high, such as is entirely free from under water. Drainage must be as near perfect as possible, either naturally or artificially. This in fact is a primary necessity for *every* crop, unless it be such as is aquatic or subaquatic.

Deep ploughing, thorough harrowing and leveling with that valuable implement the "smoothing harrow," to get a smooth and level surface, are the next operations. This should be done, in the Southern States, from 1st to 20th October, or at such season in the fall as would be soon enough to insure a growth of 4 or 5 inches before the season of growth stops. Draw out lines on the prepared land 20 inches apart (if for horse culture, but if for hand culture 14 inches) and 2 or 3 inches deep. These lines are best made by what market-gardeners call a "marker," which is made by nailing six tooth-shaped pickets 6 or 8 inches long at the required distance apart to a three by four inch joist, to which a handle is attached, which makes the marker or drag.

* The cultivation of lucerne, called on the Pacific coast alfalfa (*Medicago sativa* of the botanists), is of immense importance in certain dry soils. This paper is written by a competent authority, Mr. Peter Henderson, of New York.

The first tooth is set against a garden line drawn tight across the field, the marker is dragged backwards by the workman, each tooth marking a line; thus the 6 teeth mark 6 lines, if the line is set each time; but it is best to place the end tooth of the marker in a line already made, so that in this way only 5 lines are marked at once, but it is quicker to do this than move the line. The lines being marked out, the seed is sown by hand or by seed-drill, at the rate of 8 to 12 pounds per acre. After sowing—and this rule applies to all seeds, if sown by hand—the seed must be trodden in by walking on the lines, so as to press the seed down into the drills. After treading in, the ground must be leveled by raking with a wooden or steel rake along the lines lengthways, not across. That done, it would be advantageous to use a roller over the land, so as to smooth the surface and further firm the seed, but this is not indispensable. When seeds are drilled in by machine the wheel presses down the soil on the seed, so that treading in with the feet is not necessary. After the seeds germinate so as to show the rows, which will be in from two to four weeks, according to the weather, the ground must be hoed between, and this is best done by some light wheel-hoe, if by hand, such as the "Universal." On light sandy soil, such as in Florida, a man could with ease run over two to three acres per day. The labor entailed in this method of sowing alfalfa in drills is somewhat greater than when sown broadcast in the usual way of grasses and clover, but there is no question that it is by far the best and most profitable plan, for it must be remembered that the plant is a *hardy perennial*, and is good for a crop for eight to ten years. Moreover, the sowing in drills admits of the crop being easily fertilized, if it is found necessary to do so; as all that is necessary is to sow bone-dust, superphosphates, or other concentrated fertilizer between the rows, and then stir it into the soil by the use of the wheel-hoe. In the ground of Mr. Bronson, of Saint Augustine, Fla., he found that the seed sown in the middle of October gave him a crop fit to cut in three months after sowing, and three heavy crops after, during the same year; and I have little doubt that in that climate and soil, so congenial to its growth, that six heavy green crops could be cut annually, after the plant is fairly established, if a moderate amount of fertilizer was used, say 300 pounds of superphosphate or bone-dust to the acre. Mr. William Crozier, of Northport, Long Island, one of the best-known farmers and stock-breeders in the vicinity of New York, says that he has long considered alfalfa one of the best forage crops. He uses it always to feed his milch cows and breeding ewes, particularly in preparing them for exhibition at fairs, where he is known to be a most successful competitor, and always takes along sufficient alfalfa hay to feed them on while there. Mr. Crozier's system of culture is broadcast, and he uses some fifteen or sixteen pounds of seed to the acre, but his land is unusually clean and in a high state of cultivation, which enables him to adopt the broadcast plan; but on the average land it will be found that the plan of sowing in drills would be the best.

Mr. Crozier's crop the second year averaged eighteen tons, green, to the acre, and about six tons when dried as hay. For his section—the latitude of New York—he finds the best date of sowing is first week in May, and a good cutting can be had in September. The next season a full crop is obtained when it is cut, if green, three or four times. If to be used for hay, it is cut in the condition of ordinary red clover, in blossom; it then makes after that two green crops if cut; sometimes the last one instead of being cut is fed on the ground by sheep or cattle.

Mr. E. M. Sargent, Macon, Ga., writing to us, under date March 6,

1883, says: "I consider alfalfa to be the most valuable forage plant that can be used in this section of the country, that is the entire cotton belt, or north of it, if the land is sandy without a clay subsoil too near the surface. Planters are just beginning to find out its merits; and no poverty of stock will ever occur where alfalfa is raised. In the summer of 1881, when everything else was parched here with heat and drought, this alone was prompt in its maturity for the mower. It should be cut for hay when in blossom, and can easily be cut three or four times here, wherever the land is in fairly good condition.

"Those who *do not* succeed with it, sow it broadcast and surrender it to the hogs early in the season. Those who do succeed sow in drills 18 inches apart and cultivate early."

It will be seen that Mr. Sargent advises drills much wider than we recommend, which I presume is to admit the horse-hoe, but a quicker crop undoubtedly would be got at 14 inches apart, and by use of the hand "Universal Wheel-Hoe," the work could be done on light nearly as quickly as by horse cultivator.

Alfalfa is extensively grown in Europe, particularly in Fra Germany, where it is considered a valuable crop for rotation, classed by the French as one of the *plantes ameliorantes;* for in ern France wheat has been successfully raised after six or seven y of alfalfa on ground, which formerly had failed to give good cro wheat. Although alfalfa may be grown in cold latitudes as well warm, as the plant is entirely hardy, yet its value is not so mark cold climates where it finds competitors in red clover and the g but in light soils, anywhere, particularly in warm climates, its rooting properties make it comparatively independent of m hence it is the forage plant *par excellence* for the Southern Stat when it is considered that immense sums are paid annually for hay, by the Southern to the Northern States, not only for the hay but to freight it, the wonder is how long they will continue to with the material at hand to produce a better article at probably fourth the cost.

At the date of our writing, thousands in Florida and other Southern States are engaged in the culture of oranges, and other fruits, and vegetables for the Northern markets—and while in specially favored locations success has attended these enterprises, yet it is doubtful if four makes it profitable; while, with the culture of this valuable plant, the vast sums paid for Northern hay would not only be but the products of the dairy would assume an importance among most farmers in the extreme Southern States, is alt ther known.

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